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A Lake Trip on an Ore Carrier—Correction—Failure of a Highway Bridge under a Traction Engine (illustrated)—Use of Nut-Locks—A Crisis in City Government in San Francisco.

THE TUBULAR DISPATCH CO. of New York formally opened on Oct. 7 in New York City a pneumatic postal dispatch system in which are used the largest tubes ever installed. There are two tubes 8½ ins., inside diameter, extending from the general Post Office underground to the Produce Exchange, a distance of about 3,750 ft. These tubes are composed of 12 ft. sections of cast-iron pipe. The operating machinery, placed in the basement of the Post Office, consists of a special duplex compressor, built by the Rand Drill Co., of New York, from specifications prepared by Mr. B. C. Batcheller. The compressor is rated at about 55 HP. with 125 lbs. steam pressure when running at about 80 revolutions per minute. In operation the air flows in a continuous current from the compressor through the transmitting tube to the Produce Exchange and back through the return tube to a storage reservoir from which the compressor takes its supply. In this way the air is used over and over, a valve being provided on the reservoir to admit sufficient external air to make up for losses. The initial pressure is adjusted so that the air returns to the receiving reservoir at about atmospheric pressure. In the present installation 6 lbs. per sq. in. is found ample, while a longer line would require a proportionately greater starting pressure. The transmitter and receiver used are entirely automatic, the former being provided with an arrangement which controls the time between carriers. So far 6 seconds is found to be the limit. The carriers are riveted cylinders made of 1-32 in. tool steel, 6 15-16 ins. inside diameter and a trifle over 2 ft. long; 3 ins. from either end is a packing ring 1⅝ ins. wide by ½ in. thick, held in place by brass clamp rings firmly fixed to the outside of the cylinder. The hinge lid is locked by an ingenious cam device, which has three bolts and cannot possibly open while the carrier is in the tube. At the formal opening of the system cylinders were sent containing a variety of articles, ranging from wine in bottles to a live cat and from 16 volumes of school books to a complete suit of clothes. In actual service the carriers will carry about 600 letters each. The time required to make the round trip from the Post Office to the Produce Exchange and back is about 3¼ minutes, including taking out, unloading, loading and returning at the other end. This gives a transmission speed of something over 3,000 ft. per minute.

A BREAK IN A 48-IN. WATER MAIN at the intersection of Madison Ave. and 48th St., New York city, occurred early Sunday morning, Oct. 10, flooding the streets and basements for some distance and doing damage of various kinds estimated at $25,000. The break is said to have resulted from a blast which cracked the pipe, but the break did not occur until some six or eight hours after the blast. It is also alleged that rust along the lines of the break showed that the pipe had been cracked for a long time. The main was exposed at or near the break for the purpose of laying a sewer prior to changes in the track of the Metropolitan Traction Co.——At Cleveland, O., a 36-in. water main burst on Oct. 8.

THE LEGALITY OF THE USE OF METERS at Albany, N. Y., and the shutting off of water on failure to pay meter rates has been affirmed by New York State Court of Appeals, which sustains a decision of the lower court.

SLOW SAND FILTRATION FOR PHILADELPHIA is recommended by Mr. Thos. M. Thompson, Director of Public Works, as a solution of the water supply problem of that city. This recommendation is made in a report to the city council after an investigation of the subject. Mr. Thompson believes the Schuylkill and Delaware Rivers should be retained as sources of supply. He speaks in favor of meters, these being an absolute necessity in case the Schuylkill is the sole source of supply. Mr. Thompson expresses himself as strongly in favor of keeping the water supply wholly in control of the city, but also refers to the necessity of being forced to negotiate with private companies for an improved supply, owing to the financial condition of the city.

ANOTHER NEW YORK ELEVATOR ACCIDENT occurred at the Hotel Waldorf a few minutes before 4 p. m. on Oct. 8. As far as can be learned at present, the facts are these: The car, with the elevator operator and another hotel employee, was on its way down from the 10th floor, when suddenly the speed began to increase, accompanied by a peculiar grating noise. The operator, fearing something was wrong, threw the controlling lever to the central or stop position. Almost immediately the car reversed and shot upwards fully 10 ft., only to fall again at a very rapid rate. At the bottom the car struck a false floor on the same level as the office with sufficient force to jam this floor down some distance and to tear down several electric light wires. The two men in the car were badly shaken, one having a leg broken. The elevator machinery was installed by the Whittier Machine Co., formerly of Boston, Mass., and was what is known as a horizontal cylinder multiple sheave hydraulic type. On Sept. 28 the Fidelity and Casuality Co., of New York, made a careful inspection of the elevators in the hotel, including this one, and pronounced them in good condition and perfectly safe. It is further reported that the four ¾-in. cables were practically new. From the construction of the machine and the description of the accident, as furnished by the elevator operator, it would seem that for some cause, at present unknown, the cables or part of them broke near where they were anchored. If this occurred the only thing supporting the hanging cable and car would have been the friction of that portion of the cable wrapped around the sheaves and the sheave faces and bearings. The instant the cables broke, as described, there would be nothing to prevent the cables unwinding at a rapidly increasing rate, and a noise resembling that described would very likely have been produced. This would also account for the non-action of the safety clutches, which were operated by the release of the tension of the cables and not by a centrifugal governors and would consequently only operate when the lifting cables were very slack, or actually broken outside the sheaves.

THE MOST SERIOUS RAILWAY ACCIDENT of the week is reported from Hutchinson, Kan., on Oct. 6. It was the result of a 70-ft. stable car of a circus train jumping the track at the west end of the station yard. One man was killed instantly and three were seriously injured.

THE ELEVATED RAILWAY LOOP IN CHICAGO was put in partial operation on Oct. 11, when the Metropolitan West Side Elevated Ry. made connections and began operating its trains around the loop. The Chicago & South Side Elevated road is now building a short elevated line to connect with the loop line. The loop, which has been described in our columns, follows Van Buren St., Wabash Ave,. Lake St. and Fifth Ave., and has numerous stations. It is operated by electricity, on the third-rail system, and will eventually be used by all four of the Chicago elevated railways. The Northwestern line is not yet completed.

THE PURCHASE OF SWISS RAILWAYS by the government is provided for in a bill which has just passed the National Council of Switzerland. This bill provides for the purchase of the five principal railways of Switzerland at a cost of about $200,000,000. A loan is projected to secure the money. In January, 1897, according to the official returns, there were 2,304 miles of railway open for traffic in Switzerland.

A NEW TRANSATLANTIC RECORD from Sandy Hook to Plymouth has been made by the new North-German Lloyd steamer "Kaiser Wilhelm der Grosse," which broke the westward Southampton record on her maiden trip, as noted in our issue of Sept. 30, 1897. The new eastward record is 5 days, 15 hours and 10 minutes as compared with 6 days, 10 hours and 32 minutes, which was the time of the Hamburg-American steamer "Fuerst Bismark," and, previous to the present run, the best eastward transatlantic record. The distance sailed by the "Kaiser Wilhelm der Grosse" in her new record-breaking trip was 2,962 knots, making the average speed 21.91 knots per hour. The day's runs were as follows: 307, 504, 500, 507, 510, 519 and 55 knots. These figures beat all previous records for crossing the Atlantic. The comparative dimensions of the "Kaiser Wilhelm der Grosse" and other large transatlantic liners and also a table showing the different transatlantic records made during the last four years were given in our issue of Sept. 30, 1897.

THE SUBMARINE WRECKING BOAT "ARGONAUT," invented by Mr. Simon Lake, of Baltimore, Md., and described in our issue of Aug. 26, 1897, has been tested at the dry dock of the Columbian Iron Works, where she was built. The vessel was sunk in 26 ft. of water, and it is stated remained submerged two hours. Six men accompanied the inventor in the descent. As will be remembered, this vessel is intended to travel on the bottom by means of two toothed wheels in front and a guide wheel in the rear, and it is the inventor's plan to use it to recover the cargoes from sunken vessels.

A NEW FLEET OF TRANSATLANTIC STEAMERS for service between Havre, France, and New York city, will be constructed by the Compagnie Generale Transatlantique, according to recent press dispatches from Paris. The new steamers will, it is stated, be built to have a speed of 22 knots per hour.

DESIGNS FOR A NEW TRAINING SHIP for the U. S. Naval Academy have been prepared by the Navy Department, and bids for building it are about to be called for. The principal dimensions are: length, 175 ft.; beam, 37 ft.; draft, forward, 15½ ft.; aft, 17½ ft.; displacement, 1,100 tons. The hull will be built of steel sheathed with wood and coppered. There will be accommodations for 13 officers, 180 cadets and 90 men. The vessel will be propelled by sails, the spread of canvas being 15,000 sq. ft. Two steam boilers will be provided to furnish steam to run the windlass, pumps, ventilating and electric lighting plant, etc. The battery will consist of six 4-in. rapid fire guns and a secondary battery of four six-pounders and two one-pounders.

THE TORPEDO BOAT "STILETTO," which has been undergoing repairs at the government torpedo station at Newport, R. I., was sunk Oct. 9, by the failure of a derrick chain and the consequent fall of the heavy boiler. Partially successful efforts were made to beach the boat and thus prevent sinking in deep water. Later temporary repairs were made and after several hours of hard work the "Stiletto" was placed on the ways and drawn out of water.

ELECTRIC TURRET TURNING GEAR will be used on the battleships "Wisconsin," "Alabama" and "Illinois." Secretary Long, after considering a number of proposals, has accepted the offer of the General Electric Co. to install the machinery at a price said to be $10,000 per ship.

AN ELECTRIC CAR FOR FIRE ENGINES has been introduced by the Watson Mfg. Co., of Springfield, Mass., which bids fair to meet with considerable success. The car consists of two motor trucks supporting between them a platform large enough to hold a regulation fire engine. The extreme length is 30 ft. 10½ ins., greatest width 8 ft. 6½ ins. and height of car floor above the track 9½ ins. The total weight, including trucks and suspended floor is 14,000 lbs. The car can be propelled by motors mounted upon the axles as is customary at present, or it may be drawn by an electric locomotive, or an electric car can be impressed in an emergency. To load on a fire engine the side channel beams are released from the front truck and lowered until the front end of the floor rests upon the ground. The forward truck is then run ahead out of the way, the engine backed into place and drawn on the platform by a winch on the rear truck. The front truck is then run back to its former position and the channels raised to place by a windlass. In the course of a recent test it was demonstrated that the car could be run into position, uncoupled, the engine loaded on and all made ready for a trip in 2¼ mins. Better time was made in unloading, only 1¼ mins. being required to detach the forward truck and hitch the horses ready for a run.

THE EXPERT COMMITTEE appointed to report on the advisability of Philadelphia establishing a municipal lighting system has submitted its report. The committee, composed of M. R. Muckle, Jr., J. J. DeKinder and A. S. Vogt, found that the city used 7,119 lamps at an average cost of 33.3 cents each per night. They recommended the establishing of four plants in different sections of the city. The report further describes the location and character of buildings and machinery for each station. The cost for an overhead system is placed at $1,562,731 with an annual expense of $583,664, which would amount to about $82 per lamp per year, or nearly 22½ cents per night. For an underground system the cost is estimated as $3,475,867, and maintenance $732,210, or 28 cents per lamp per night.

THE EXTENSION OF THE POWER PLANT OF THE NIAGARA FALLS POWER CO.

By Orrin E. Dunlap.

That the Niagara Falls Power Company's great power development is a success is well demonstrated by the enlargement of the plant now in progress. For many months a large force of men has been at work excavating an extension of the wheel-pit in order that more powerful turbines may be installed, and the power house is being extended over this wheel pit extension to provide room for additional generators. From an engineering point of view the wheel-pit extension is an interesting work, and in the installation to be placed there several changes will be made as compared with the original section of the pit. In the construction of the new section of the wheel-pit, channelling machines were used by the contractors to cut the rock, which was blown out in benches by the use of dynamite. The charges of this explosive were not so large in the extension as in the original pit, for fear of injuring the machinery now in use in the power house. The depth of the new section of the pit is 179 ft., and the excavation has been completed. The original section of the power house is 140 ft. long, while the extension is 286 ft., making a total length of 426 ft., which length covers the wheel-pit. The average width of the pit is 20 ft., and this is increased at the top to make room for masonry walls 6 ft. wide. These walls are carried down to solid rock, the width between them being 21 ft. In the construction of this section of the pit a change was made in placing the penstock mouthpieces. In the original section of the pit these were not placed until the dynamos were about to be installed, but in the new section all the mouthpieces, seven in number, have been built right into the wall. This is so that when dynamos Nos. 7 to 10 inclusive are installed, no masonry will be necessary, it having been completed in advance. It has also been found advisable to increase the size of the openings directly under the dynamos, and this will be done in the new work.

Another notable change is the new method to be adopted in supporting the girders in the pit. In the old pit the girders are built right into the walls, whereas in the new section they will be supported on castings placed in the walls. Dr. Coleman Sellers, the chief engineer of the Niagara Falls Power Company, has also suggested changes in the method of supporting the turbines in the pit. In the present installation the turbines are supported on girders, but by consulting the drawings in connection with this article it will be seen that the wheelcase and lower penstock elbows of the new installation will have projecting ribs supporting them on castings, which in turn will be bricked into the walls, as is made clear in the illustration.

When the tunnel and first section of the wheel-pit were constructed, the "muck" was used for filling in and reclaiming land under water on the upper Niagara river. On some of this land factories to-day stand, many acres having been so reclaimed. The "muck" from the present work has been used in filling in beneath the trestle of the Niagara Junction Railway, which is owned by one of the companies allied with the Niagara Falls Power Co. By this means the roadbed of the railway has been made more substantial, and as it is all on the Niagara Falls Power Co.'s lands, it is an improvement beneficial to that company, as the road furnishes terminal facilities to all plants on the power company's property. When it was raised out of the pit the "muck" was loaded on to dump cars and pulled by a small engine to the trestle for dumping. The wheel-pit contract was awarded to E. D. Smith & Co., of Philadelphia, and this firm made rapid headway with the work. At present the lower portion of the pit is being bricked to a height of about 40 ft., the wall to be about 30 ins. in thickness. In all about 1,500,000 brick will be used, and these will be furnished by Brush Brothers, of Buffalo. On the west side of the new section of the power house a new conduit is provided for light and power cables, while the main subway is to be extended.

FIG. 1.—GENERAL VIEW OF LANDS OF NIAGARA FALLS POWER CO., SHOWING EXTENSION OF WHEEL PIT IN PROGRESS.

Fig. 1 gives a bird's-eye view of the Niagara Falls Power Company's lands, and shows the work on the wheel-pit extension with great clearness, while Fig. 2 shows the size of the enlarged power house as defined by the structural steel frame. The exterior walls will be of the same beautiful stone construction as the present section of the power house, and the extension will materially add to the impressiveness of the building. The extension provides room for the placing of seven additional generators of 5,000 HP. capacity each, but only five new generators are to be placed in the next installation, which will bring the power house product up to 40,000 HP., and when the two additional generators are placed the product will be 50,000 HP., which is the proposed full capacity of this station. The tunnel, however, is of sufficient capacity to allow the development of 100,000 HP., and the plan is to build another power station of the same capacity on the side of the canal immediately opposite the present station, the inlets being already built to provide a water service. The new turbines are being built by the I. P. Morris Co., of Philadelphia, the design, it will be recalled, being that of Faesch & Piccard, of Geneva, Switzerland. The new generators are being built by the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa. It was these same firms that built the original turbines and generators, which have proved so efficient in all their parts and mark the installation as the greatest in the world.

In the present installation, current for exciting the fields of the generators is obtained from 200 K-W. rotary transformers which stand at one end of the switchboard structure, but in the new installation four small turbines will be placed down in the pit and will operate four exciters to be located on the power house floor. This change will result in giving an absolutely independent source of power supply for the exciters.

All the work on the extension of the power house and wheel-pit is being done under the personal supervision of William A. Brackenridge, M. Am. Soc. C. E., who is the resident engineer of the Cataract Construction Co. Mr. Brackenridge was connected in a prominent way with the construction of the tunnel and first section of the power house and wheel-pit, and his experience is found to be a very valuable aid in securing rapid progress and efficient results in the present work. The electrical installation in the power house extension will be under the watchful eyes of Mr. L. B. Stillwell, M. Inst. Elec. E., who is now connected with the power company as electrical expert, and Mr. Paul M. Lincoln, who is the electrical superintendent. The steel work was erected by the Buffalo Structural Steel Co., while the masonry work on the power house is being done by R. D. Young & Co., and the carpenter work by Braas Brothers, the last two firms being of Niagara Falls.

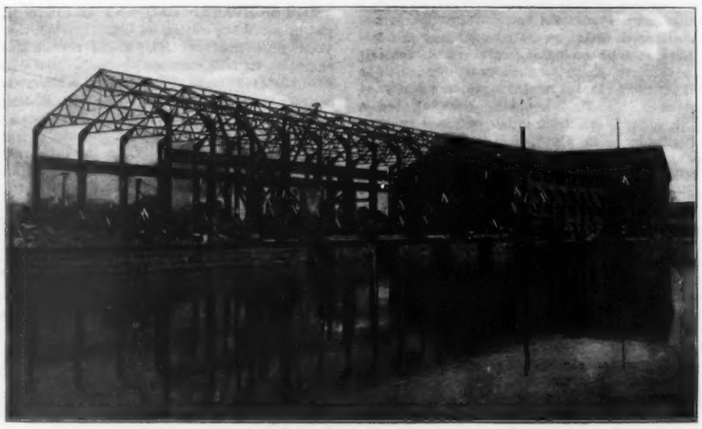


FIG. 2.—STEEL FRAME FOR EXTENSION OF POWER HOUSE, NIAGARA FALLS POWER CO.

A DIVING BELL FOR DEEP WATER WRECKING.

A special form of diving bell, which has a closed bottom and is thus practically a movable air-lock, is now being used in an endeavor to recover a cargo of copper ore and copper ingots from the sunken steamer "Pewabic," which went down in Lake Huron, near the city of Alpena, Mich., in August, 1865. Various attempts have been made to recover the valuable cargo, upon which the Aetna Insurance Co. has paid $61,000 for insurance, but all previous attempts have been unsuccessful, the wreck lying in 160 ft. of water, which is too deep for divers or ordinary methods of submarine work. The form of diving-bell now being tried is the invention of Mr. Worden G. Smith, General Superintendent and Secretary of the American Wrecking and Salvage Co., of Milwaukee, Wis., but Mr. Smith is not willing to give details of his apparatus, on the ground that while parts of it have been patented, it included improvements and ideas in this line of work which may not be patentable, and might be made use of by others to his disadvantage. He states that he does not know of the system ever having been employed before, and that work has progressed somewhat slowly, owing to windy weather, the position being exposed. Work has now been stopped for the season. It may be interesting to note that while copper was worth about 25 cts. per lb. at the time this cargo was lost, it is now worth only about 11 cts. per lb., the cost of production having been greatly reduced, while the demand has increased to an enormous extent.

Recently Mr. J. S. Gadsden, General Agent of the Aetna Insurance Co., visited this work, and from a description given by him and published in the "Inter-Ocean," of Chicago, we take the following extracts. Mr. Gadsden informs us that this description is correct:

The diving bell in which we descended to the bottom of the lake is a cylinder 8 ft. high and 6 ft. diameter, inside measurement, constructed of steel an inch thick, with five windows of glass 2½ in. thick. It is equipped with a weight of 1,000 lbs., attached to the bottom, and also a water bottom that will hold 1,000 lbs. of water. The water ballast can be pumped out with a force pump, worked by hand, when the bell is sunk, and the other ballast weight can also be detached, so that, should anything go wrong with the hoisting arrrangement, the pressure of air in the bell will raise it to the surface at any time when the weights are cast off. The whole weight of the bell is over 7,000 lbs.

The bell was lowered from the wrecking barge over the sunken steamer by a derrick to near the water level, and three of us entered from the top, air was pumped in, and the cover put on. Then we descended. For 20 ft. or so from the surface of the water there was a slight leak at the edges of the cover, but as we got down deeper the overhead pressure was so great that it was sealed tight, and not a drop came through. We were in telephonic communication with the surface all the time, and the bell was lighted by electricity. We were lowered first on one side of the steamer, which we inspected. It was a hazy day, and rather dark; still at that depth we could see the heads of the bolts that held the gunwale of the steamer in place at a distance of six or seven feet. Then we were lifted and moved over to the other side of the vessel. Through the glass in the sides we could see on every side through the water. The bell has four legs on the outside, worked by cogs and cranks from the inside, for balancing it on the bottom, where there is a sloping surface. There is also a little propeller wheel for moving it round to any desired position, also worked from the inside.

An ingenious feature consists of two steel rods, working in ball-bearing joints or journals, which pass through the bottom of the bell, and at their ends are grappling hooks

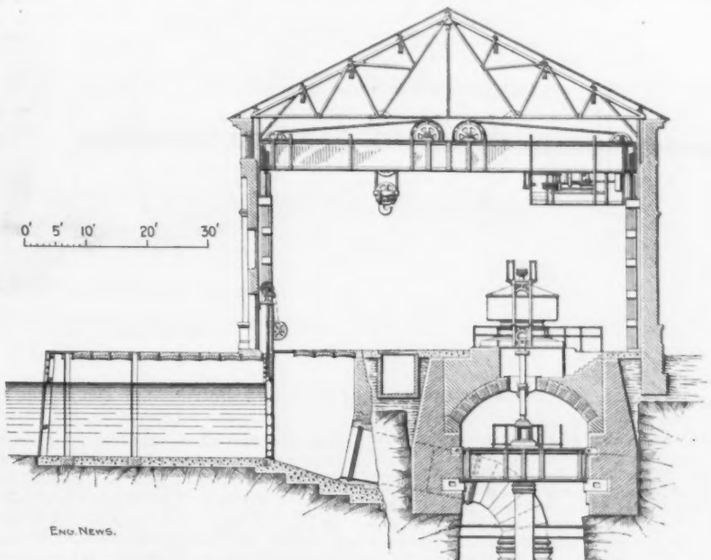


Fig. 3.—Vertical Cross-Section through Power House and Wheel Pit, Showing General Arrangement of Dynamos and Turbines.

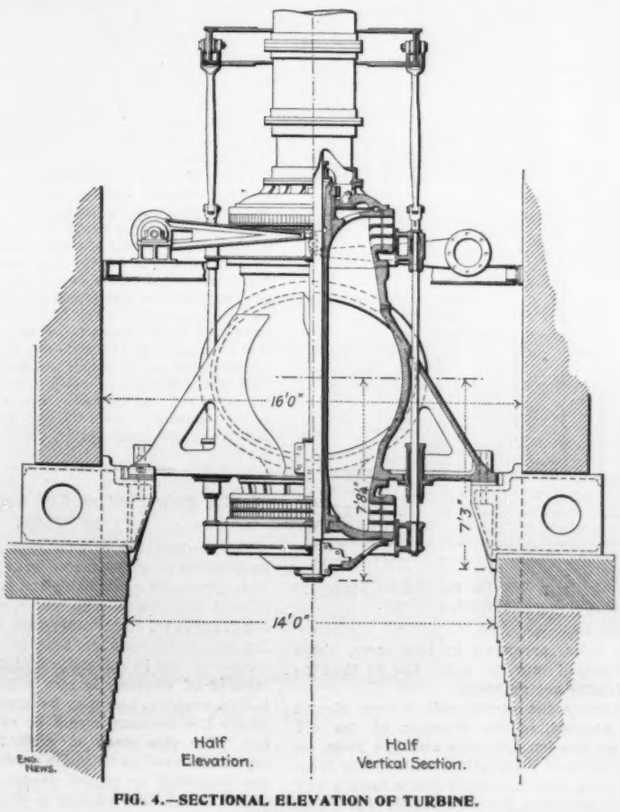


FIG. 4.—SECTIONAL ELEVATION OF TURBINE.

for handling the wreckage. A piece of rock was lowered from the surface, and it was pushed into a position where it would hold the cable to which it was attached. Then a piece of dynamite was lowered and was placed in position in the same way. An electric wire was attached to it, and we told them to lift us up. When the dynamite was exploded the surface of the lake was greatly agitated, and large numbers of lake trout were killed by the shock, and soon were seen floating on the water.

When I was there about 30 tons of copper had been recovered, but there were 200 tons on the steamer when she was sunk. It is believed that, as the vessel was struck in the bow and went down head foremost, much of the copper went through,and is now under the hull. No copper can be found in the hold, and this is the theory we have for its absence there. The vessel was built of oak, and the mainmast and some of the fenders recovered are but little the worse for having lain in the water 32 years. The iron, except where it was protected, is badly corroded. The steamer was built for carrying passengers and cargo, and cost $200,000. The captain of the steamer, Captain Kay, is still alive, and he says she sunk as I have stated.

The inventor of the bell claims that it can be lowered to a depth of 450 ft. with perfect safety, and, by putting in heavier glass, to a depth of 1,000 ft. We are not running any risks by the venture. We simply give the company the exclusive rights to raise as much of the cargo as they can for a percentage of what they raise. One piece of copper already lifted weighs over six tons. Part of the copper was in ingots and part of it unsmelted, as it was taken from the mines.

NOTES FROM THE ENGINEERING SCHOOLS.

Massachusetts Institute of Technology.—The new freshman class numbers about 400. The number of college graduates taking courses in the Institute is larger than usual. The president's chair, left vacant by the death of Gen. Francis A. Walker, is still unfilled. Prof. James M. Crafts, of the chemical department, is chairman of the faculty, pro tem.

Stevens Institute of Technology.—Prof. James E. Denton has been appointed professor of mechanical engineering, in the place of the late Prof. De Volson Wood. The professorship of Physics, made vacant by the death of Prof. Alfred M. Mayer, has been divided, Prof. Wm. E. Geyer taking the chair of General Physics and Electricity, and Prof. D. S. Jacobus the new chair of Engineering Physics, with charge of the physical laboratory.

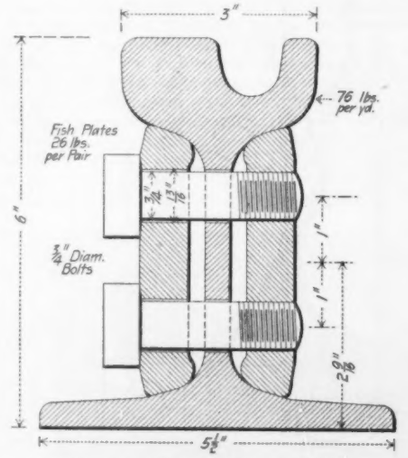
A MONSTER FREIGHT LOCOMOTIVE for the Mexican Central Ry. has been built by the Brooks Locomotive Works, of Dunkirk, N. Y. It is of the consolidation type, but with the addition of a trailing truck under the huge Belpaire firebox, the firebox being designed for burning either wood or bituminous coal. Behind the engine is an eight-wheel tender, carrving 5 tons of coal and 4,500 gallons of water. The leading dimensions of this machine are as follows:

Driving wheels	4 ft. 1 in.
Truck wheels	2 ft. 4½ ins.
Wheelbase, driving	13 ft.
" total of engine	28 "
" engine and tender	53 "
Weight on driving wheels	145,200 lbs.
" front truck	23,450 "
" rear truck	24,800 "
" total	193,450 "
Cylinders	21 × 26 ins.
Boiler, diam. of barrel	6 ft. 6 ins.
" height from rail to c. line	9 ft.
Working steam pressure	180 lbs.
Firebox	10 ft. × 3 ft. 1¾ ins.
" depth at front	6 " 3 "
" depth at back	6 " 10 "
Tubes, 412; diameter	2 "

GIRDER RAILS FOR ENGLISH STREET RAILWAY TRACKS.

Girder rails on street railways have been used in England very extensively for many years past, but there has also been a very general use of built-up track having rails of box or flangeless T section carried on cast-iron supports or chairs. In the construction of the street railways (operated by horses) at Bristol, England, some years ago, the engineer, Mr. Joseph Kincaid, M. Inst. C. E. (of London), used his patented form of track with box (or double-web) rails in chairs on concrete base, but in the recent construction of extensions to be operated by electricity, girder rails were used instead. In view of the growing attention which is being given to railway track construction in this country, we wrote to Mr. Kincaid for a statement of the reason for the adoption of this type of track, and his reply is given below.

The rail used on the Bristol Tramways extensions is shown in the accompanying cut. It is 6 ins. high, 5½ ins. wide on the base and 3 ins. wide over the head, weighing 76 lbs. per yd. The splice bars weigh 26 lbs. per pair, and are secured by eight ¾-in. bolts, arranged in two rows, these bolts being tapped into the outer bar so that no nuts or nut locks are required.



Cross-Section of Girder Rail for the Bristol Tramways (England); Joseph Kincaid, Engineer.

In this country the girder rail is now almost universally adopted, to the exclusion of the old strap rails on wooden stringers and box rails, on iron chairs, some of these girder rails being from 7 to 10 ins. high, with fish-plate joints having two rows of bolts and from 8 to 12 bolts in each joint. This, if properly supported, makes an excellent and rigid track, but an objection which has been urged to it is the enormous proportion of metal which goes to scrap when the rail head becomes worn, although on the other hand the rate of wear on our modern rails has been greatly reduced by the use of steel with an unusually high percentage of carbon, making the rail both hard and tough. In view of the amount of wear due to the wheels of heavy electric cars and of wagons crossing the track, a form of rail having a detachable and renewable head has frequently been put forward as the ideal form for street railway service. For heavy traffic, however, it appears impracticable to make such a rail sufficiently stiff between supports, or to devise a fastening of the rail to the supports (either continuous or intermittent supports) which will not get slack and allow of motion between the rail and its supports. This is very clearly explained by Mr. Kincaid in his letter.

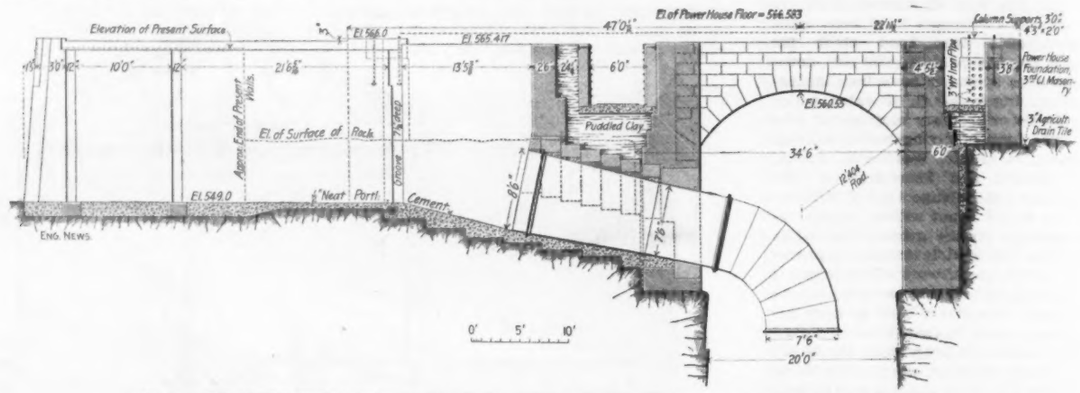


FIG. 3.—ENLARGED CROSS-SECTION THROUGH INLET AND WHEEL PIT ON CENTER LINE OF PENSTOCK.

For the slow speeds of tramways worked by horse power the tee rail which I have generally used in the construction of a large mileage of tramways in this country was most suitable, but for the high speeds which had to be provided for, of late years, in consequence of the introduction of mechanical power, the tee rail was not sufficiently rigid and the maintenance of the joints and fastenings became difficult. The grider section of rail is the one wherein this maintenance can be best and most economically provided for. As a rule, however, the girder rail has been very badly designed; the groove is not sufficiently deep and the shoulders of the flanges of the rail have not been properly designed so as to receive fish-plates which give the maximum amount of stiffness to the joints.

I have pleasure in enclosing you a tracing of the rail which I specially designed and have extensively used in this country, wherein these points have been specially considered. It is true that in this section of rail there is a very large amount of metal compared with the amount of metal available for the wear and tear of the traffic, but no plans that I have seen giving a detachable and renewable head have appeared to me to be good, as of course any making up of the rail in parts involves certain fastenings and fixings which do not stand the heavy wear and tear of great loads and high speeds. In fact the rail required under the conditions and prices we have in England is a comparatively small portion of the cost of the tramway, and the maintenance is an important element in the designing of the work, and we find that the girder rail meets the conditions of our lines better than any other.

PLACER MINING DREDGES ON GRASSHOPPER CREEK, MONTANA.

The application of dredging machinery to the excavation of gold-bearing gravel deposits in river beds has made practicable the economical working of such deposits in deep water, and the use of ladder dredges for excavating gold-bearing gravel under such conditions has been practiced successfully for some time in Australia and New Zealand. This method of working is now also being introduced in this country, and may be applied in many cases where the deposits would be otherwise inaccessible. For this class of work the ladder dredge has been found to be much more satisfactory than the clamshell or dipper dredge, for various reasons. In the first place it is practically impossible to keep the bottom door of the dipper water-tight, even with rubber packing, and the clamshell bucket is even less water-tight, so that the escaping water carries off much of the gold contained in the gravel brought up by the bucket. Besides this, both of these types cause considerable disturbance of the gravel bed, causing the light and finely di-

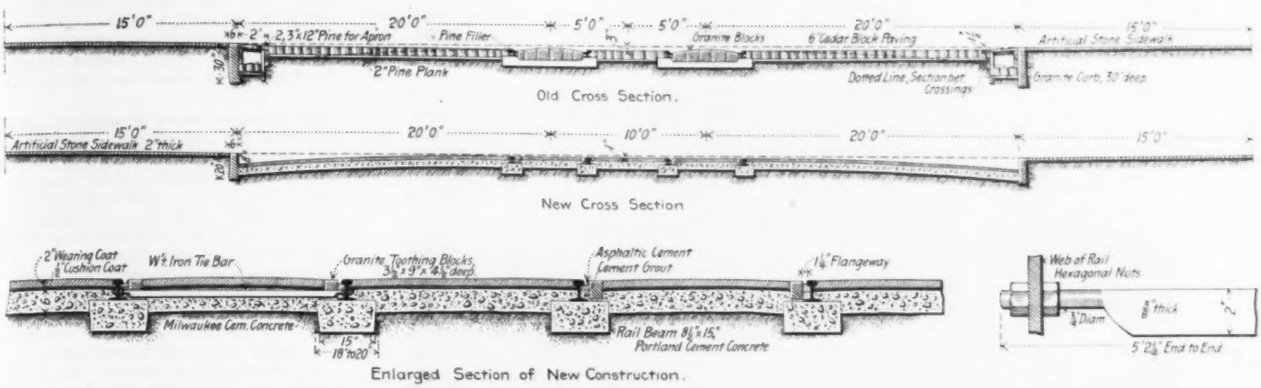


FIG. 1. CROSS SECTIONS OF OLD AND NEW STYLES OF STREET RAILWAY TRACK.

FIG. 2. DETAILS OF TIE-BAR.

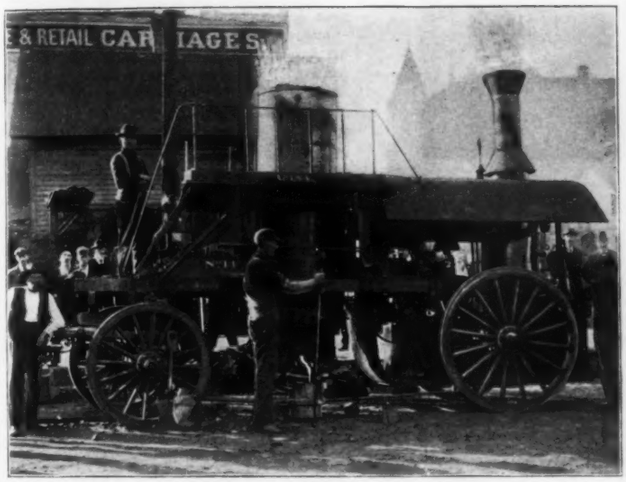


FIG. 3. PORTABLE CUPOLA FOR CAST WELDING TRACK-JOINTS.

FIG. 7. GENERAL VIEW OF STREET RAILWAY TRACK UNDER CONSTRUCTION IN MINNEAPOLIS.

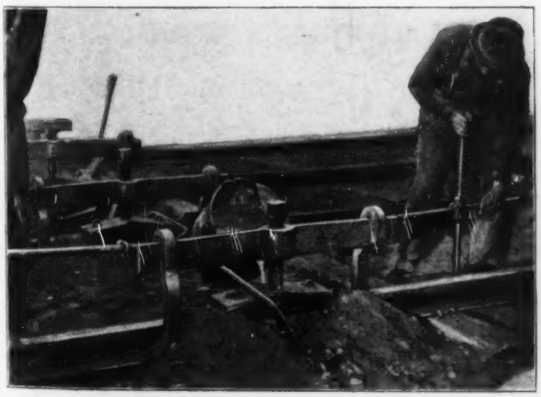


FIG. 4. POURING THE JOINT.

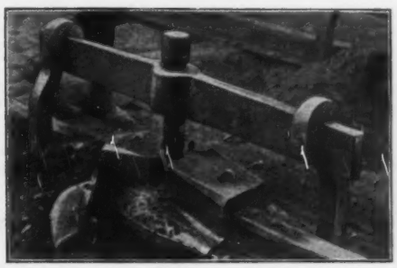


FIG. 5. VIEW OF THE MOLD OPENED AFTER CASTING.

FIG. 6. VIEW OF THE COMPLETED JOINT.

PERMANENT STREET RAILWAY TRACK CONSTRUCTION IN MINNEAPOLIS, MINN.

vided gold to work its way down deeper into the bed. In the latter dredge, the buckets are watertight and retain their contents until discharged into the hopper, and the slow and steady movement causes a minimum of disturbance of the surrounding gravel, besides which the amount of water in the bucket facilitates the process of washing.

We illustrate herewith a steam ladder dredge used by the Bannack Dredge Co. for work in the gold-bearing gravel and stone deposit of the bed of Grasshopper Creek at Bannack, Mont. This is one of four dredges at work on that creek, two of which are owned by this same company, one being operated by steam and the other by electricity. Fig. 1 is a general view of the machine, and Fig. 2 shows the arrangement of the machinery, etc. The buckets discharge their contents into a hopper in the usual way, and from this the material passes to a revolving screen of cylindrical form, the diameter of the screen being sufficient to allow the passage of the largest stone (usually 18 ins. to 24 ins. diameter) that can be brought up by the buckets. The length of this screen is sufficient thoroughly to disintegrate and wash the material, jets of water being directed into the interior of the screen, so that the gravel is thoroughly washed. The openings in the side of the screen vary in size according to the character of the material, and are from 1 to 6 ins. in length, all stones, etc., more than 6 ins. in length being thrown overboard after having been thoroughly washed. From the screen this material falls into a chute which discharges it over the side of the boat, the chute being high enough and steep enough to discharge the material so far from the boat that the accumulated debris will form no obstruction. The fine material, including the gold, together with a considerable proportion of water, flows out from the bottom of the screen into a sluice-box, from the lower end of which a chute extends over the stern of the dredge, this chute being of proper size and inclination and having a series of riffles to catch the gold. A stream of water from a centrifugal pump is discharged into the upper end of the sluice-box, and the discharge chute is made long enough to collect all the gold and deliver the tailings clear of the dredge.

The dredge illustrated has a hull 102 ft. long, 32 ft. wide and 6 ft. deep, with a draft of 4 ft. It will dredge to a depth of 35 ft. below the water line, and the normal speed of the bucket chain is such as to deliver 16 bucket loads per minute into the hopper. The buckets are of steel, with a capacity of 5 cu. ft. per bucket. The bucket chain is driven by an engine of 75 HP., having two cylinders 10×14 ins. The screen is 4 ft. diameter and 12 ft. long. The water jets to the screen and sluice-box are delivered by a 15-in. centrifugal pump of 100-HP., driven by a double cylinder vertical compound engine with cylinders 12×14 ins. and 22×14 ins., the pump making 200 revolutions per minute. Steam is supplied by two boilers of locomotive type, 5 ft. diameter and 18 ft. long. The boat is revolved slowly upon one of two stern spuds, these spuds being used alternately so as to feed the dredge against the breast of the excavation. Wire cables are also led from each side of the bow to shore anchorages, and the boat is moved forward or in a lateral direction by hauling in or paying out the ropes as required, this being done by independent winding engines.

As already stated, the Bannack Dredge Co. has also an electric dredge at work. This is similar to the steam dredge in every respect, except that it is driven by electric motors instead of steam engines. The power plant has a capacity of 250 HP., and there are two electric motors of 100 HP., one for driving the bucket chain and the other for driving the pump. An English company working on the same creek is building a steam dredge with hull 110 ft. long, 36 ft. wide and 7 ft. deep, with a draft of 4 ft. It has a ladder frame 75 ft. long, and will dredge to a depth of 45 ft. below the water line. The buckets are of 7½ cu. ft. capacity, and the speed of the bucket chain is such as to deliver 16 bucket loads per minute. The main engine is of 125 HP., with cylinders 12 × 16 ins., and the 18-in. centrifugal pump is driven at a speed of 180 revolutions per minute by a vertical inverted engine of 125-HP. Steam is supplied by two boilers, 5 ft. 6 ins. diameter and 20 ft. long. A fourth dredge of the same type is also at work on this creek, being operated by the Chicago Mining & Development Co. This latter machine was originally a suction dredge, but as it did not prove satisfactory the machinery was replaced with the ladder dredging machinery and revolving screen as used on the Bannack company's dredge, the original centrifugal pump being retained for the water jets.

The first three machines were designed and built by the Bucyrus Co., of South Milwaukee, Wis., and we are indebted to Mr. A. W. Robinson, Engineer of the company, for cuts and information made use of in this article. The Bucyrus Co. also furnished the dredging and screening plant for the fourth machine.

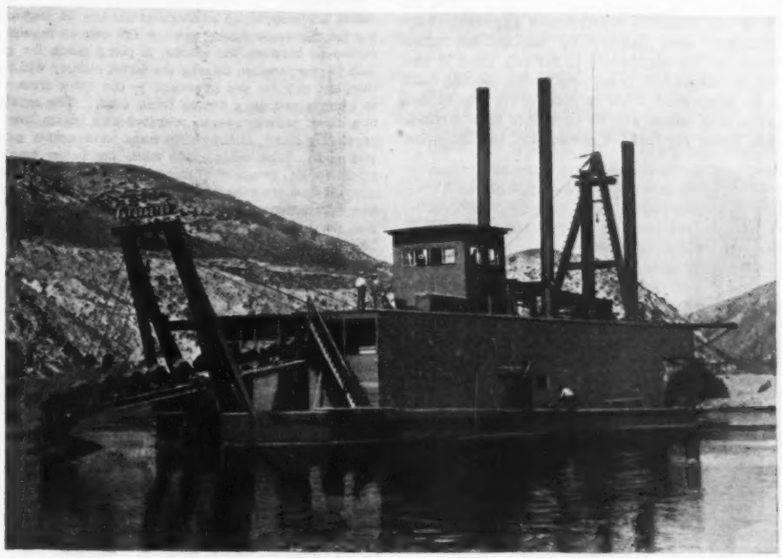


FIG. 1. STEAM DREDGE FOR PLACER MINING AT BANNACK, MONT.
The Bucyrus Co., Builders.

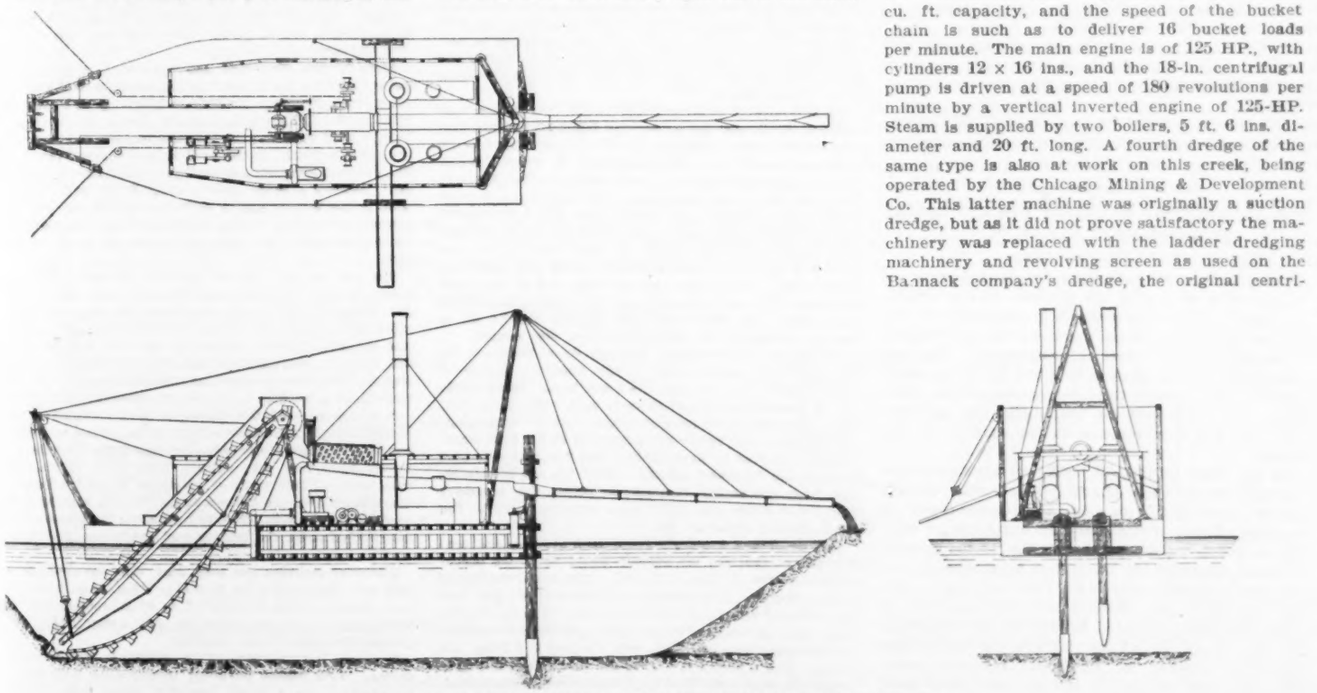
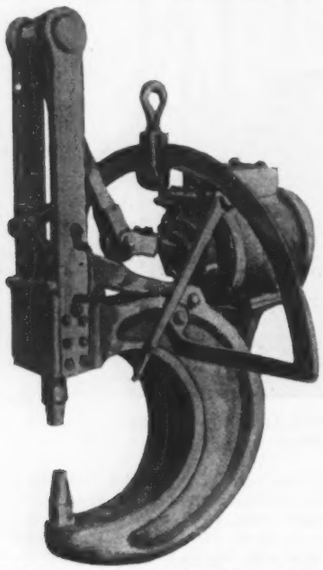


FIG. 2.—PLAN AND SECTIONAL ELEVATIONS OF PLACER MINING DREDGE.

A NEW UNIVERSAL HANGER FOR POWER RIVETING MACHINES.

We illustrate herewith one of the various forms of riveting machines made by Chester B. Albree, Allegheny, Pa., with a novel means of suspension, called a "universal ball." The ball, being bent to an arc of a circle, whose center is the center of gravity of the machine (determined approximately by calculation and exactly by experiment after completion of the machine), it follows that if the machine is suspended from any point on the ball it will be supported from a point over its center of gravity, and hence will be in stable equilibrium. The ball, being pivoted on trunnions, the machine



Field Riveting Machine with Universal Ball. Chester B. Albree, Allegheny, Pa., Builder.

can be put in any conceivable position and will remain there. In practice it is clamped tight, to avoid accidentally moving its position when working.

The advantages of this improvement will be apparent, we are sure, to everyone familiar with the use of power riveting machinery.

THE CONSTRUCTION OF STREET RAILWAY TRACKS IN MINNEAPOLIS AND ST. PAUL.

(With full-page plate.)

With the growing demand for good paving on city streets, and with the increase in the weight and speed of street cars, there is gradually coming to the front a better and more permanent method of construction of street railway tracks. The advantages of such construction are in the reduced cost of maintenance, the easier and smoother running of the cars and the keeping of the rail surface in its proper relation to the surface of the street.

In our issue of Oct. 15, 1896, we discussed editorially the systems of track construction which seemed most likely to meet the requirements of electric railway service, and in our issue of Oct. 29 we published a brief description of the system of track construction which has been adopted on the street railway lines of St. Paul and Minneapolis. At about the same time a full account of this work was presented by Mr. F. W. Cappelen, M. Am. Soc. C. E., at the Chicago meeting of the American Society of Municipal Improvements. We have been favored by Mr. Cappelen with several photographs illustrating the work described in his paper; and while press of other matter has considerably delayed their presentation, the importance of the subject and the practical value of Mr. Cappelen's paper will make it appreciated by our readers, we are sure, at the present time. The paper was in substance as follows:

On ordinary railways the entire track is, practically, constantly patrolled, so that the roadbed and track can be kept in as good a condition as the management desires. Low joints are readily raised, bad ties easily exchanged for good ones, bolts tightened, etc., as everything is in plain view to the men in charge. On a street railway the conditions are entirely different. After the track is down, nothing is visible but the top or running surface of the rail, and when a joint sags it means the ripping up of the pavement of the street at that point to do the required work of putting track in proper alinement and to proper grade.

The same is the case when removal of ties or rails becomes necessary. In addition to the cost of properly caring for the track itself, there is the cost of repairing the pavement between the tracks, it being taken for granted that the corporation owning the street railway will at least care and pay for the pavement in the space from outside to outside rail on a double track road. The repair bills in a street railway system operated with horses were comparatively small, although the track construction generally was poor. The cable roads made far better track construction an absolute necessity, and companies that attempted and are attempting light and poor track construction for electric street railways have found or will find that the expense for maintenance of track is a big item. The ordinary horse car weighs about 11,000 lbs., the cable car 12,000 lbs., and the electric car from 19,500 lbs. to 43,000 lbs.

The city of Minneapolis was one of the first in the United States to change its horse railway system into an electric system, and the entire change of 100 miles was made in one year. The company did not, however, change track and rail very much, but used a great amount of 4-in. light rail—45 lbs. and 54 lbs. per yd. The Johnson 78-lb. girder rail was also used, and after considerable wrangling the city council permitted the company to use the "Shanghai" 6-in. 70-lb. T-rail on some new extensions.

As most of the streets were paved with 6-in. cedar blocks, on 2-in. foundation plank, a great deal of trouble was experienced with the pavement next to the rails and between them. The ties had to be cut down or 4-in. blocks were used, etc. With the 6-in. T-rail, strips of wood were placed along the rail to form the groove for the flanges of the car wheels to run in. The rails were spiked to pine ties on 2-ft. centers and almost any material was used for ballast. This construction is shown in Fig. 1. In a good many cases cobblestones were used between the rails. The city charter provides that the space between rails must be paved with the same material as the balance of the street, but the city council would occasionally grant the company the right to do differently. After a while asphalt was ordered on certain streets and the street railway company was obliged to look at the matter of track construction in a little different way, but it finally got permission to pave between rails and tracks with granite, and the city put granite toothing on the outside of the rail. The 6-in. 78-lb. Johnson girder rail was used, but no particular care was taken in the ballasting of the tracks and the result was that it settled and the asphalt broke away after a short period.

In 1896 several of the principal down-town streets were ordered paved, and the writer was delighted to learn that the street railway company would do every thing in its power to construct a first-class track in every respect. For all crossings and curve work, the so-called Johnson, Pa., guaranty work was used. All switches and frogs have removable Harveyized steel pieces, and it is expected that this work will stand in the worst places for at least nine years. The life of the old frogs, etc., did not exceed five years, and was generally pretty bad after two years' wear. Ties were used for this part of the track and they were set in concrete and the entire intersections and cross-overs were paved with fine-cut granite set in cement mortar and the joints were filled with cement.

All straight track work is laid with 60-ft. T-rails of the 80-lb. section, recommended by the American Society of Civil Engineers, 5 ins. high and 5 ins. base. Three methods of constructing the track were used. The same company owns the street railway system both in Minneapolis and St. Paul, and work was commenced in St. Paul somewhat earlier than in Minneapolis. The first plan was used there in the following manner: After the sub-foundation had been thoroughly rammed or rolled, the necessary slight excavation was made for a concrete beam to run longitudinally under the rail.

This beam was 8 ins. deep and 15 ins. wide, and constructed so that the top surface would be at the proper grade to receive the base of the rail. The beam was formed between boards. The concrete used consisted of 1 part Empire Portland cement, 2½ parts sand and 4½ parts crushed rock. Upon the beams, after they had set, the rails were placed and tied together every 10 ft. with tie-bars ⅜ × 2 ins., set on edge. This is shown in Fig. 1, and the tie-bars in Fig. 2.

After the rails were lined up, the joints were cast-welded, room being left in the concrete every 60 ft. for the joints. The street railway company experimented in the winter of 1895-96 with the so-called Falk cast-welded joints, and adopted them for all the future work. The joint is made in the following manner:

The rails where the joint is to be made, are first thoroughly cleaned with files and emery paper. Cast-iron molds are then placed around the joint, held in place with clamp screws both horizontally and vertically. It was found necessary to have a very heavy vertical screw to prevent the joint from heaving on account of expansion due to the heat developed. After the molds were placed, the molten metal was poured and the joint thus completed. After cooling the molds were removed and any rough edges left were trimmed off. The joint is made so that a flange way is formed in the cast. The company owns two of the so-called cast-welding machines made by the Falk Mfg. Co., of Milwaukee, Wis., and one of them is shown in Fig. 3.

The cost of the machine is about $2,500, and the capacity 8,500 lbs. per cast. The joint for the 80-lb. rail requires about 138½ lbs. of metal, and the cost per joint is about $2. This includes the cost of fixing the rails to receive the joint. A 45-lb. rail requires 102 lbs. for a joint, and a 54-lb. rail requires 115 lbs. for a joint. A mixture of half pig and half scrap castings gives the best results. The furnace is loaded in layers, beginning with wood, then coke and pig, coke, pig, etc.

After the joints were made, Milwaukee cement concrete, 6 ins. thick, composed of 1 part of cement to 2½ parts of sand and 4½ to 5 parts of rock, was placed to proper grade to receive 2½ ins. of asphalt pavement across the entire street and between rails and tracks, leaving enough space on the inside of the rails to place along them granite blocks 4½ ins. deep, 3½ ins. wide and 9 ins. long.

These blocks were, however, set simultaneously with and in the concrete, being separated from the head of the rail by a 1¼-in. wooden strip, so as to form the flange way for the car wheels. After the strip was removed, the lower 2½ ins. of the space left was filled with cement grout and the upper 2½ ins. to the top of the rail was filled with asphaltic cement, consisting of about 30% asphalt and the balance limestone dust. This mixture remains soft enough to form the proper groove when the first car is run over the track. The joints between the granite blocks were filled with asphaltic cement. After the track work was completed as described, the asphalt pavement proper was put down flush to the top of the rails everywhere but in the groove.

Considerable trouble was experienced in St. Paul with the rails after the joints had been cast. In a little while about 1,500 ft. of track looked like a snake and it was very difficult to get the track back in line, in fact the superintendent of the street railway company thought he would be obliged to cut the rails, but he got along without doing so. When the work came up in Minneapolis, this matter was discussed and it was thought advisable to proceed in a different way.

Ties were placed about every 6 ft. to 8 ft. apart, and the rails were lined up and temporarily fastened to the ties, then the cast-weld joints were made, and the concrete beam put in between the ties in the same manner as in the first case. The ties were then pulled out, the space filled, and the balance of the street concreted and completed as before. The rails were also spiked to the concrete beam, as soon as it was in place. The track was kept in perfect alinement in this way.

After further discussing the work as it progressed, a further modification in constructing the beam was adopted. As it was not always possible to follow up with the concrete work of the street proper as fast as the beam was built, a good bond was not obtained between the beam and the other concrete, so the method was changed this way. The ordinary concrete was put down outside and inside the rails, forming a rough groove about 8 ins. deep, 15 ins. wide at the bottom and 18 to 20 ins. at the top. In this groove, as soon as it was built, the beam concrete was placed, otherwise the construction was as in the second case.

The cost per foot of rail for the concrete beam construction only, including grading for same, was in the first place 26 cts., in the second case 26 cts., and in the third case 27 cts. The filler cost about 5 cts. per ft. The cost of putting down temporary ties and laying, lining and surfacing one mile of single track preparatory to putting in the concrete beam, and including labor and material used in welding the joints, are (approximately) $850.

In connection with this change of track construction, the writer changed the cross-sections of the streets as well as the intersections where repaving was done. All the old streets have very deep gutters, from 12 to 15 ins., and even more. This made it necessary at intersections to use bridges over the gutters at the corners, making same unsightly in the first place, and generally the gutters were easily filled under the bridges, and finally too much space of the street was lost.

Wherever repaving has been done this was changed, so that now the gutters are only 6 to 8 ins. deep, with corners of the streets rounded off to 12 ft. radius, and the street raised at the corner so that only a step to the pavement of from 4 to 5 ins. is needed.

Drainage is taken care of by putting in double catch-basins. This makes beautiful intersections and pleases everybody. On a 50-ft. roadway, paved with asphalt, and without tracks, 8-in. gutters and 10-in. crowns are used; with tracks, 8-in. gutters and 7-in. crown from rail.

The cost per mile of a double track constructed as related would be about as follows:

Putting down temporary ties, and laying, lining, surfacing, joints, etc., of double track	$1,700
Beam work, etc.	6,968
4 rails (60 ft. each; cost $2 a ton more than 30 ft. rails) and tie-bars	9,400
Asphalt paving at $2.43 per sq. yd., 10-year guaranty	15,840
Total	$33,908

This is a very heavy expense and it is sincerely hoped that the construction will prove satisfactorily. About 2½ miles were completed in Minneapolis in the season of 1890.

As far as the writer knows the construction has only been used in Montreal, Toronto and perhaps Detroit. In the two Canadian cities the cast-welded joint was not used. The writer would suggest that a different T-rail be used, viz.: A rail 6 ins. high with a 6-in. base. The 4½-in. granite blocks ought to be 5½ ins. deep, and 6 ins. base would give a better bearing on the concrete beam. It may be of interest to note that the Warren-Scharf Asphalt Paving Co. claims a patent on the method of forming the asphaltic flangeway before referred to. This company did all the paving on streets with car tracks, and Mr. E. M. Ayers laid all streets without tracks, using Utah limerock asphalt.

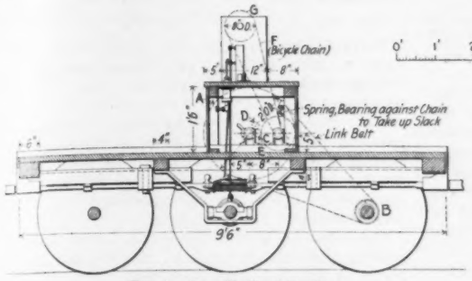


Fig. 1.—Longitudinal Section.

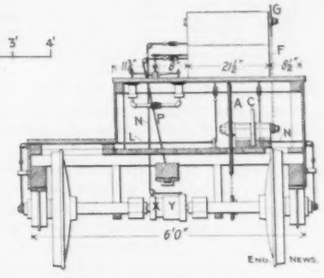


Fig. 2.—Transverse Section.

DYNAGRAPH CAR FOR CHICAGO CITY RY. CO.

A DYNAGRAPH CAR FOR STREET RAILWAYS.

We illustrate in the accompanying engravings the principal structural features of a dynagraph car for recording defects in street railway track, which has been very successfully employed by the Chicago City Ry. Co., of Chicago, Ill. This company operates some 190 miles of track on the "South Side" of the city of Chicago, the greater part of which is cable and electric trolley line, and it often becomes a serious problem to decide between the relative cost of track repairs or renewal and the cost of extra motive power due to track somewhat out of repair, when inspection by eye alone is adopted. It was thought profitable, therefore, to investigate whether some more exact and at the same time practical method of determining defects in the track could not be devised, and the result of this study was a special dynagraph car, designed to measure and record automatically high and low joints, defects in gage, defects in rail level, and draw bar pull. This car has now been in use for some time, and has proved so satisfactory for the purpose intended that it is recognized as a part of the standard apparatus used by the engineering department of the company.

The general construction of the dynagraph car will be understood from Figs. 1 and 2, it being simply a platform car carrying on its top a suitable cabinet to protect the recording mechanism. There are three pairs of wheels, of which the center pair has a free vertical and longitudinal movement of the axle, while the end pairs carry the car body without intermediate springs. The recording of low joints and gage defects is done by the center pair of wheels, whose rise and fall and longitudinal axle movement actuate a recording device, to be described later. For recording defects in rail level, or, more definitely, the difference in height of opposite rails on straight track, there is a special leveling device, while the draw bar pull is recorded by a dynamometer spring.

Taking the determination of low rail joints first, it will be seen that when such a joint is met the forward wheel of the car first drops into it, and this causes a relative rise in the midway wheel, which is recorded on the paper in one direction from the normal line; next the midway wheel drops into the low joint, and a longer deflection is made from the normal line in the opposite direction from the first deflection; and, last, the rear wheel drops into the joint, which causes a movement and record by the center wheel similar to those caused by the drop of the front wheel. It will be seen then that the passing of the three wheels over the joint causes the recording pen point to make two short deflections in one direction, and betweeen these a much longer deflection in the opposite direction. Of course, only the middle or longest deflection is used in determining how low the joint is.

To record defects in gage, that is, the spreading of the rails at joints, a longitudinal expansion and compression of the axle carrying the midway wheels is provided for by cutting out about 9 ins. of the axle at the center and inserting a spiral spring in place of the removed part. This spring holds the wheel flanges against the rails at all times—contracts for narrow gage and expands for wide gage. The inner ends of the cut axles are supported in journals, which allow lateral and vertical movements of the midway wheels, but do not allow similar movements of the midway axles at these inner journals in reference to the car.

The operation of the apparatus for recording the motions just described is explained by Figs. 1 and 2. The sprocket wheel A is driven by a link belt from the car axle B, and from the axle of the sprocket wheel A the spur wheel and axle C is driven by the intermediate gears D and E. From the axle C the bicycle chain F drives the sprocket wheel G, operating the main roller, coated with emery flour, which drives the paper, as shown in Fig. 3, in which H is the driving roller, J the roller from which the paper unwinds and K the roller onto which it winds. The roller K has a small grooved wheel, and the roller J a larger wheel, so that, by means of a belt, J drives K a little faster than it moves itself, and this always keeps the paper taut. The gearing is so proportioned that the paper travels 1 ft. for every 1,000 ft. travel of the car. To trace the records on this paper there are five pen points, as shown in Fig. 3. Each pen point is carried by a lever arm, which is actuated by the center axle movement, the leveling device or the dynamometer spring. Taking up first the center axle movement, it will be seen that the dropping of the wheels into low joints actuates the cords L and M, respectively (Fig. 2), and through them the levers L and M (Fig. 3), while the compression and expansion of the axle spring actuates the cord N (Fig. 2), and through it the lever N (Fig. 3). These three diagrams show defects in gage and the low joints for each rail.

The instrument for recording differences in level of opposite rails is shown in detail by Fig. 4 and in position on the car by Fig. 2. Referring to Fig. 4, it will be seen that two cylinders of wood float in two cups of mercury, connected so as to allow free flow from one to the other. A difference in the level of opposite rails causes the mercury to flow from one cup to the other and a consequent fall and rise of the opposite wooden floats, which, by means of their piston rods and the rocking lever, actuate the recording lever O (Fig. 3) and describe a line on the paper.

The draw bar pull acts on a dynamometer spring Z (Fig. 1), which, by its extension and compression, actuates the recording lever P (Fig. 3) through the cord P (Fig. 1). The draw bars are supported on roller bearings, and owing to the location of the spring between their inner ends, a record can be made with the car going in either direction by simply inserting a pin in the rear draw bar so that it cannot move.

From the foregoing, the construction of the car will be pretty clearly understood, with the exception of the minor details and a few other features, among which the eccentric roller is most notable. This is operated by the crank Q (Fig. 3), and its purpose is simply to hold the pen points off the paper. If this is not done, the paper, when not moving, absorbs ink and becomes so soft that when started the glass pen points catch and break off. Another construction of interest is the spring box, which replaces the center portion cut out of the center axle (Fig. 2). This device consists of two hollow cylinders, one of which, X, slides inside of the other, Y. Inside of X, 4 ins. interior diameter, is placed a 4-in. diameter coiled spring. On their caps both X and Y carry hardened conical pivots, which fit into conical recesses in the ends of the axle B.

In operation the only adjustment that the car requires is to start with the zero draw bar pull upon the zero line, which is drawn as the paper moves by a pen point, attached to a fixed arm. To obtain the best results, it is necessary to haul the car with an electric motor car at a uniform speed of not more than 4 miles per hour. The car was designed by Mr. W. G. Price, M. Am. Soc. C. E., mechanical engineer, Chicago City Ry. Co., Chicago, Ill., who has furnished us the information from which this description has been prepared.

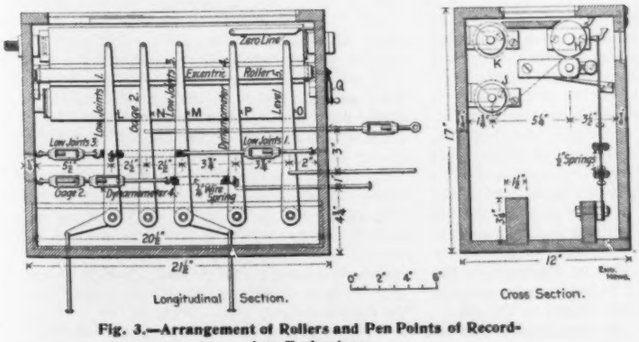


Fig. 3.—Arrangement of Rollers and Pen Points of Recording Mechanism.

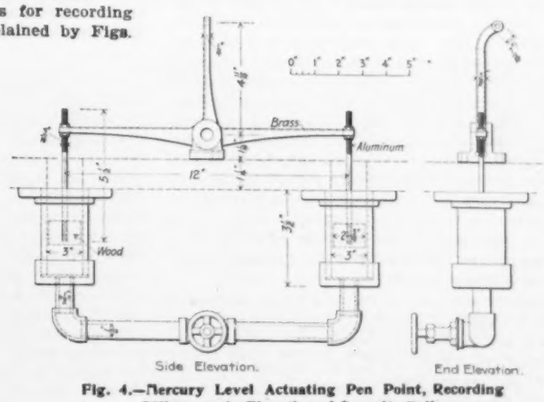


Fig. 4.—Mercury Level Actuating Pen Point, Recording Differences in Elevation of Opposite Rails.

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The ability of the modern steel skeleton building to withstand a severe fire, with but comparatively little damage to its framework, is becoming more certain with each fire to which such buildings are subjected. As we pointed out in our issue of May 20 the excellent behavior of the steel framing of the Horne store in the Pittsburg, Pa., fire of May 3, was one of the most notable and instructive facts brought out by that disaster. The same fact is shown more impressively, if it is possible, by the Leonard Building, which was burned in the fire at Detroit, Mich., on Oct. 7, as is briefly described elsewhere in this issue. This building was ten stories high and of steel skeleton construction, with the columns and principal floor beams fireproofed with hollow tile, but with ordinary wooden floors and, apparently, entirely without partitions on any floor, and very presumably, with open stairways and elevator shafts between the different floors. The rear windows, through which the fire was communicated, were entirely unprotected with shutters, giving the flames free access to each floor, filled with furniture and other highly combustible material. Under these conditions it is not surprising to find that the building was entirely gutted of its contents, and that the steel framing was stripped of its fireproof protection and outside walls. The great wonder is that the integrity of the framework was preserved at all, yet it is found, to quote our correspondent, that:

> The columns and many of the floor beams and girders are still straight, as nearly as can be told from the closest inspection I have been able to make. The girders carrying the walls and most of the roof framing are too badly twisted to be of any further use, but the whole framework stands apparently solid, and it is claimed that much of it will be fit to use again.

It may be, of course, that some modification of these statements will be found necessary when all the details are at hand, but the broad fact cannot, we think, be altered that the steel frame of this building was its most durable part under very unfavorable conditions of exposure to fire.

In our issue of Sept. 16 we referred to the good work which the Commissioner of Patents is doing in weeding out and disbarring from practice before the office some of that class of patent solicitors commonly and correctly designated as "sharks." The Patent Office "Gazette," of Oct. 5, contains a full and highly interesting account of the proceedings before the Commissioner in the case of John Wedderburn & Co., whose disbarment was approved by Secretary Bliss, on Sept. 30. Commissioner Butterworth does not mince matters at all in his published report to the Secretary of the Interior. He describes in plain terms the reprehensible methods adopted by this firm, and says:

> There is little doubt that the demoralizing influence of the methods and practices of the respondents as solicitors of patents, during their brief career, has done more to injure the Patent Office and to place the practice before that bureau on a low moral plane than the combined efforts of all the delinquent practitioners who have appeared before this office in a quarter of a century.

We urgently advise any of our readers who are in any way interested in patent matters to secure this copy of the "Gazette." Commissioner Butterworth and his able assistant, Mr. Greely, in the course of their scathing arraignment of Wedderburn, lay down in plain terms what are the duties and what should be the standard of conduct of a patent attorney toward his client, and it has never been better done.

There is just this much to be said for Wedderburn and his associates—that bad as were his acts, they were after all in many respects no worse than the methods of business which have been pursued by some of the firms that have practised before the Patent Office for many years. Other concerns have distributed matter broadcast, designed to deceive the ignorant into the belief that a fortune was easily made by inventing trifles. Other concerns have combined the business of patent soliciting with the publishing of cheap journals, in which descriptions of inventions published for pay in the reading matter columns form a principal feature. Other concerns have urged clients to patent anything and everything, and to spend money for worthless foreign patents, well knowing that their client might as well be throwing his money into the sea so far as his prospect of return was concerned.

The Wedderburn concern merely carried this method of doing business to its logical conclusion. It did a few things worse than others had done, and it carried on its business on such a huge scale that its fraudulent nature became too plain to be overlooked.

We sincerely trust that the Patent Office authorities will follow up the good beginning they have made. The nefarious business of inducing "suckers," as the Wedderburn concern called them, to try to patent trivial inventions, ought to be broken up. If the Patent Office were relieved from considering the large number of applications of this class, a needless cumbering of the office files would be avoided, besides saving from loss thousands of worthy but ignorant people.

The compressed air nozzle, as a painter's tool, seems to be quite rapidly gaining favor in railway car and locomotive paint shops, despite the marked discouragement which it received from many car painters when first advocated. At the recent convention of the Master Car and Locomotive Painters' Association, held at Old Point Comfort, Va. (Eng. News, Sept. 16), the painting of freight cars by compressed air was very fully discussed, and some of the evidence brought out in support of the practicability and economy of this method in painting certain classes of rolling stock is deserving of careful consideration by railway managers. It is but fair to state also that at least one of the objections which was raised to the system, namely, the danger to health from the fumes of the spray, must be overcome before the complete success of the compressed air system of painting in railway shops can be asserted, even by those most favorably inclined toward it.

The saving in time and money by using the compressed air spray instead of brushes was perhaps most forcibly presented by Mr. H. G. MacMasters, of the Illinois Central R. R., in a paper describing the experience had with the two systems at the Burnside, Ill., shops of that railway. Since last November the painting of practically all freight cars on this road has been done with the compressed air spray, and its use is being extended to the painting of passenger car trucks and to various other classes of rough work. Mr. MacMasters gave the comparative time and cost of painting a new box car 35 ft. long by the spray, and by brushes, as follows:

	With the brush. Time.	Cost.	With the spray. Time.	Cost.
Sills, 1 coat	20 mins.	$0.05	13 mins.	$0.03¼
Edge roof board, 1 coat.	40 "	.10	17 "	.04¼
Body, 3 coats	7 hrs.	1.05	1hr.24m.	.21
Putty	1 hr.	.15	1 hr.	.15
Roof, 2 coats	30 mins.	.07½	12 mins.	.03
Trucks, 1 coat	1 hr.	.15	20 "	.05
Blacking off irons, etc.	25 mins.	.06¼	25 "	.06¼
Total cost		$1.63¾		$0.57¼

These figures, it is to be remembered, were those actually obtained in practice, and show a saving of $1.06, or 64.73 per cent. in the cost of painting a single car. A saving of 7½ lbs. of paint per car was also obtained by using the spray. In painting passenger car trucks the corresponding saving in cost was 37½ cts., or 83⅓ per cent. per truck. It is hardly necessary to say that such economies as these are eagerly looked for by railway managers.

The objection is sometimes raised that comparisons of this kind fail to take into account the interest on the cost of the plant for painting by compressed air. This criticism really amounts to very little, however, except perhaps in very small shops where the installation of a compressed air plant must be made for painting alone. In most railway shops of the present day a compressed air plant already exists for operating cranes, air hoists and other tools, and practically all the extra expense necessary to extend the air pressure to the paint shop is the cost of the necessary pipes and connections. A simple calculation will show, however, that under ordinary conditions the saving obtained by using the compressed air spray will pay a good rate of interest on any investment which will be required for plant. As a case in point, we may take the saving of $1.06 per car shown by the figures which are quoted above, and which were obtained in painting a lot of 120 new box cars now being built by the Illinois Central R. R. Co. For the whole 120 cars the saving will be in round figures $127, or 6 per cent. interest on an investment of $2,120, which would certainly be ample to install a compressed air plant, including boilers and piping, adequate for any ordinary railway paint shop.

The strongest objection against the use of the compressed air nozzle which was brought out by the discussion of Mr. MacMaster's paper at the convention was, as has already been stated, the danger to health from the fumes of the paint spray getting into the lungs and eyes of the workmen. Mr. MacMasters admitted that this was the worst feature of the system, but very pertinently drew attention to the fact that offensive fumes from the paint spray are largely a matter of the construction of the spraying machine. It is a matter of common knowledge to those who have paid any attention to the subject, that many of the spraying machines which have been used for painting are very poorly designed affairs. While it is probably true, as was stated at the convention, that none of the sprayers thus far used is entirely free from fault in this respect, it is also plain from the experience of the railway shops which have successfully used the compressed air spray, that some of these machines are quite free from offensiveness. Naturally, too, the trouble from flying paint spray is greater in a poorly lighted and ventilated shop than it is in a light, airy shop or out of doors. Mr. MacMasters, as we have had occasion to say before (July 23, 1896), has one of the best lighted and ventilated railway paint shops in the country, and according to his own evidence, possesses an unusually well-designed spraying machine. The reason why he has made a success of the compressed air system of painting where others have failed, undoubtedly lies very largely in these two facts. Railway managers who may be planning to adopt the compressed air system in their paint shops will do well to bear these points carefully in mind. It is not reasonable to expect that any crudely designed apparatus for throwing a spray of paint by compressed air will do any better for painting than make-shift or imperfect machines usually do in other places.

RECENT TESTS OF ACCELERATION AND BRAKING.

The importance of a rapid acceleration to the movement of cars or trains at high speed on street and suburban railways, is a matter which is receiving increased attention from railway managers. Frequent stops are a necessity in all street railway service, and the extent to which these stops will increase the total running time between terminals depends very largely on the rate at

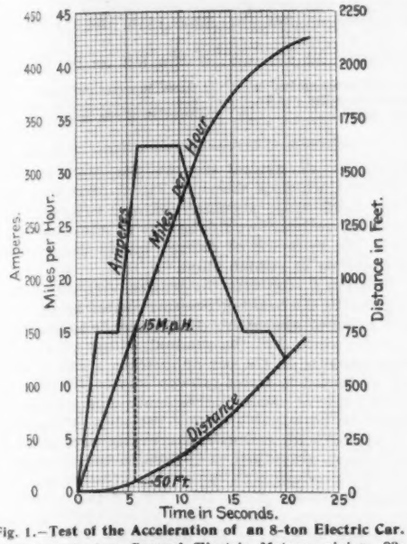


Fig. 1.—Test of the Acceleration of an 8-ton Electric Car.
(Equipment, two General Electric Motors; pinion, 33; gear, 52; Wt. of load, 1¾ tons. Total weight, 9¾ tons.)

which the motor is able to accelerate the car to its normal speed. It may be pointed out also that rapid acceleration does not, or need not necessarily, involve an extra expenditure of power. It takes no more foot pounds or energy to get a car from rest to speed of 30 miles an hour in 10 seconds than it will to make the same car reach the same speed in 30 seconds. Manifestly, however, the motor must exert three times the power to make the quicker start.

The proportion of the total power used for propulsion which is expended in acceleration depends on the number of stops and on the rate of speed that is reached between stops, but is independent of the rate of acceleration. Recent tests on the Metropolitan Elevated R. R. in Chicago, published in our issue of Sept. 16, showed that of the total power expended in propelling the trains on that system about 64% was expended in accelerating the trains. In this case the stations were about a half mile apart and speeds of 15 to 25 miles per hour were reached between stations.

Surface street railways, either cable or electric, which make more frequent stops, probably consume a still larger percentage of power in the work of acceleration, although this is partially offset by the fact that the maximum speed attained is considerably lower than on the elevated roads.

To the practical railway manager the power consumption due to acceleration is of little importance. What he desires is the quickest time in moving his cars over the roads that city ordinances and a reasonable regard for safety will permit. One principal reason for the large size of modern street car motors is the demand for rapid acceleration. It requires a comparatively small amount of power to keep a street car moving at speed on a level track; but to get it quickly under way from a state of rest requires a motor of large power.

In Fig. 1 are shown the curves from a start of an ordinary four-wheel electric car. The principal data regarding the test are given on the drawing. It will be seen that a speed of 15 miles per hour was reached in about 6 seconds, and in a distance of about 50 ft. The curve of acceleration is of rather unexpected form. With a motor which exerted power upon the car at a uniform rate the rate of acceleration should fall off as the speed increases. It takes much more power, for example, to increase a car's speed from 10 to 15 miles per hour than it does to give the same car a speed of 5 miles per hour from a state of rest. The electric motor, however, exerts more power as the speed increases and hence the curve of acceleration becomes a straight line for a considerable distance.

Fig. 2 shows a comparison between the run of an elevated railway train drawn by a steam locomotive, and the run of a cable car over the same distance. The dotted lines represent the approximate average speed in each case. It will be noticed that while the maximum speed of the elevated is about 2½ times as high as that of the cable railway the average speed is only twice that of the slower road, notwithstanding the fact that the latter makes four or five times as many stops.

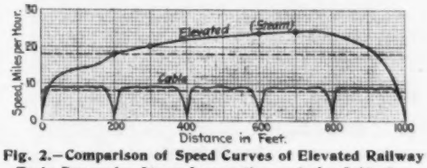


Fig. 2.—Comparison of Speed Curves of Elevated Railway Train Drawn by Steam Locomotive and of a Cable Car.

If the start and stop of the elevated trains were made as quickly as that of the cable car, its average speed between terminals could be increased some 40% without raising its maximum speed.

But when we attack the problem of increasing the rate of acceleration of a train of cars, another matter than the power of the motor must be considered—the matter of adhesion. The pull which a locomotive or motor car at the head of a train can exert is limited to about ¼ of the weight upon its driving wheels. Hence an electric motor car hauling a train of three or four trailers can make nothing like as quick starts as if it were running alone. To meet this difficulty Mr. Frank J. Sprague has recently devised a system by which a motor is placed upon each car of the train, and the whole are controlled from the leading car by the motorman. The idea, of course, is an old one; but Mr. Sprague is the first, we believe, to put it in practical operation.

In considering the question as to the proper size of motor equipment to be placed upon cars, the engineers of the General Electric Co. de-

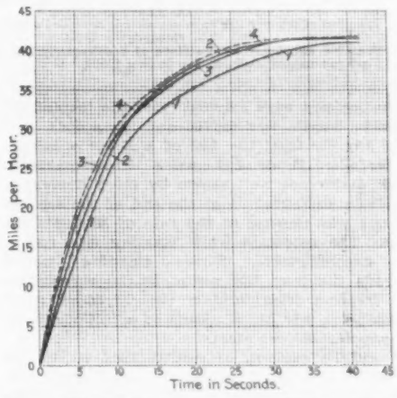


Fig. 3.—Starting Curves of 25-ton Electric Elevated Ry Car. Specially equipped for Rapid Acceleration.

termined to test the question as to what was the maximum rate of acceleration that could be imparted to a car without causing discomfort to its passengers. It was determined to equip a car to give the high rate of acceleration of 3 miles per hour per second and subject it to test. In accordance with this, Mr. W. B. Potter, Chief Engineer of the Railway Department of the General Electric Co., equipped a standard elevated railway car with a 50-HP. motor geared to each axle.

The only departure from the ordinary practice was to reduce the gear ratio and use a controller which would admit sufficient current to give the required starting torque. The total weight of the loaded car was 25 tons, including trucks, motors and passengers. This car was run on the stretch of track along the heel path of the Erie Canal, built by the General Electric Co. for motor tests. Current was taken from a pair of rails alongside the track. The curves in Fig. 3 are plotted from data obtained during four of these test starts made from rest.

The readings in the test were as follows:

Seconds from start.	Speed, miles per hour in test. I.	II.	III.	IV.
5	14	16	18	19
10	26	28	29	30
15	31	34	34	35
20	35	38	37½	38
25	37½	40	39½	40½
30	39½	41	41	..

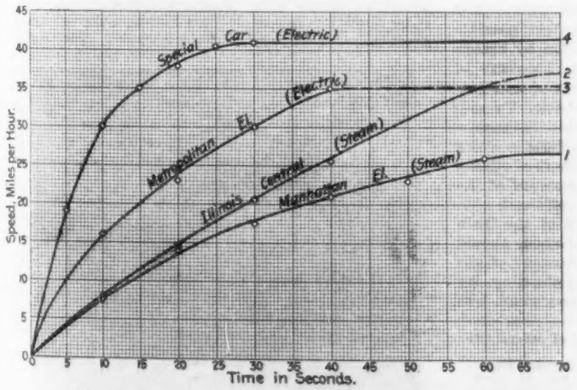


Fig. 4.—Starting Curves of Trains Propelled by Several Different Systems.

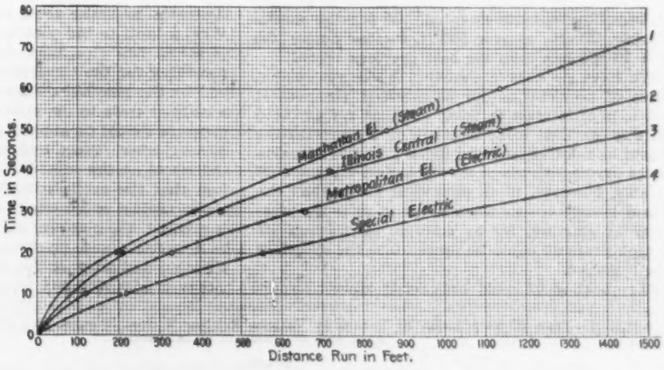


Fig. 5.—Distances Covered from Starting Point by Trains Propelled by Several Different Systems.

TABLE I.—Tests of the Acceleration of Railway Passenger Trains with Various Motors. (Figures give the average of several observations of trains in actual service.)

Railway.	No. of cars.	Weight, train, net tons.	Grade.	Tractive effort per net ton.—Maximum for given time.	Tractive effort per net ton.—Average for total time.	10 secs.—Average rate of acceleration.	10 secs.—Speed, miles per hour.	10 secs.—Distance run, ft.	20 secs.—Average rate of acceleration.	20 secs.—Speed, miles per hour.	20 secs.—Distance run, ft.	30 secs.—Average rate of acceleration.	30 secs.—Speed, miles per hour.	30 secs.—Distance run, ft.	40 secs.—Average rate of acceleration.	40 secs.—Speed, miles per hour.	40 secs.—Distance run, ft.	50 secs.—Average rate of acceleration.	50 secs.—Speed, miles per hour.	50 secs.—Distance run, ft.	60 secs.—Average rate of acceleration.	60 secs.—Speed, miles per hour.	60 secs.—Distance run, ft.
				sec. lbs.	sec. lbs.																		
Lake Street Elevated	..	..	Level.	... ...	... ...	2.25	22.6	165	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Alley Elevated, Chicago (steam)	3	72	"	10 119	40 74	1.22	12.2	90	.975	19.5	285	.82	24.6	540	.716	28.6	840	...	..	..	...	..	..
Metropolitan Elevated R. R. (electric)	2	44	"	10 167	40 91	1.64	16.4	120	1.13	22.5	330	1.0	30	660	.87	34.8	1020	...	..	..	...	..	..
Lake Street Elevated (electric)	2	44	"	10 122	40 75	1.22	12.2	90	1.02	20.5	300	.773	23.2	510	.69	27.6	870	...	..	..	...	..	..
Illinois Central R. R. (steam)	4	140	"	10 81	60 72	.817	8.17	60	.715	14.3	210	.682	20.5	450	.64	25.6	750	.622	31.1	1140	.592	35.5	1560
Special car; G. E. Wks., Schenectady, N. Y.	1	9	"	10 269	20 204	2.8	28.	206	2.05	41	600	...	..	..	...	..	..	...	..	..	...	..	..
Special " " "	1	25	"	10 282	20 186	3	30	220	1.9	38	556	...	..	..	...	..	..	...	..	..	...	..	..
Manhattan Elevated (steam)	4	95	"	10 77	60 50	.75	7.5	54.8	.62	13.5	198	.58	17.5	386	.52	21	615	.47	23.5	862	.43	26	1140

$$\text{Tractive effort per ton} = \frac{\text{Distance run in feet}}{(\text{seconds})^2 \times .0084} + 10 \text{ to } 20 \text{ lbs. friction, or}$$

$$\text{Tractive effort per ton} = \text{Rate of acceleration} \times 87.3.$$

$$\text{Speed in miles per hour} = \frac{\text{Distance run in feet} \times 1.364}{\text{Seconds}}.$$

Rate of acceleration is given in miles per hr, per second $\Big\}$ $= \Big\{$ Speed in miles per hour / Duration of run in seconds

Feet per second = Miles per hour × 1.466.

The seconds were counted from the instant the cotroller handle was moved and the speeds were read directly from the dial of a Boyer speed recorder belted to one of the axles. The remarkably quick starts are well shown by these curves; in one instance (curve 4) at the end of ten seconds the car was moving at the rate of 30 miles per hour. The sensation while starting was not at all uncomfortable. Those standing leaned towards the rear, but owing to the smoothness and freedom from jerking, the extremely rapid acceleration was by no means so objectionable as the usual cable car start.

It will be evident, of course, that under Mr. Sprague's system of placing motors on each car, a train of any number of cars could start with equal celerity, provided each had an equally heavy equipment of motors. It is doubtful, however, whether it will ever be found economical to put such a large amount of power on an elevated railway train merely for the sake of making a quick start.

In Fig. 4 are given approximate starting curves of a number of different cars and trains in elevated railway and suburban service. The advantage of electric traction over steam locomotive is admirably shown. It will be seen that for a few seconds at starting the steam locomotive is very ineffective. In plotting this diagram minor variations have been eliminated. Had these been included, the jerking motion of the locomotive in accelerating for the first few seconds would have been evident. It will be seen that in the first ten seconds a speed of 16 miles per hour is attained on the Metropolitan elevated (electric), whereas but 6 miles an hour is attained on the Manhattan elevated in the same time.

Fig. 5 gives the distances covered during the various starts plotted in Fig. 4. Taking the relative positions at the end of 10 seconds, it will be seen that the steam propelled elevated train has covered 55 ft.; the suburban steam train, 90 ft.; the Metropolitan electric elevated, 120 ft.; the special electric, 220 ft., or over 100 ft. further during the first 10 seconds than the best previous record.

We have no curves showing the corresponding rates of acceleration for compressed air motors; but it is of interest to point out that for elevated railway work at least they are on a par with the steam locomotive in being limited by the adhesion of the driving wheels of the air motor. They should be able, however, to do somewhat better than the steam locomotive in the matter of cylinder pressures at starting, for by suitable mechanism air of high pressure could be turned into the cylinders when desired.

The question of rapid braking is almost as important as acceleration in its influence upon average train speeds, for the more rapid the stop, the longer can full speed be maintained, with a consequent increase in the average speed. The air brake is in such general use as to practically equalize the stops in all systems and make the braking curve obtained in the tests already illustrated about that shown in Fig. 6. Lately electric brakes have been revived, and the General Electric Co. now has on the market a form of magnetic disk brake which is actuated by the car motors. In other words, the car motors are short circuited through the magnetizing coil of the brake and a variable resistance. A study of the figures in Table II. would seem to indicate that

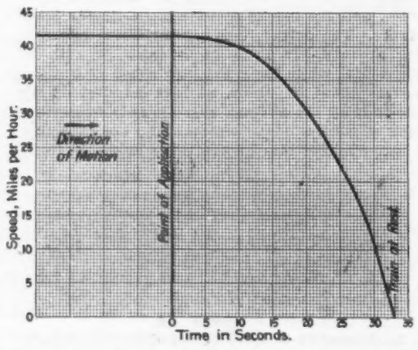


Fig. 6.—Approximate Retardation Curve of Rapid Transit Trains.

the brake does what is claimed for it—that is, makes a quicker stop than any of the air, steam or vacuum systems at present in use.

While, for the rapid movement of trains, it is desirable to make stops in the shortest possible time, a limit to the possible retardation by brakes is set in two directions, first by the necessity of providing for the comfort of passengers, and second by the possible sliding of the wheels. To stop a railway train in the shortest possible distance, a pressure should be applied by brake-shoes to every moving wheel, which will just stop short of sliding the wheel on the rail. Further, on account of the fact that the coefficient of friction of the brake-shoes rapidly increases as the speed of the train is reduced, the pressure on the brake-shoes should be a variable one, greatest at the moment of application and least at the moment of stopping. By this method a stop can be made in very much less time than the typical stop on the Metropolitan Elevated, which is shown in Fig. 6. But to make such quick stops regularly on any suburban or elevated railway would be out of the question. Only the presence of danger makes permissible the making of sudden stops.

To make a stop with the greatest comfort to the passengers the braking pressure should be applied and released gradually. The former is almost invariably done, but the gradual release of brake-shoe pressure as the car approaches a stop is not often effected in street railway service. If it were done, however, much higher brake-shoe pressures would be permissible during the stop. If brakes are applied with gradually increasing force so that passengers can adjust their position to the retarding effect, a very high brake-shoe pressure can be reached without discomfort; but, if this is done, the brake-shoe pressure must be slackened as the car nears its stop, or the passengers will be violently lurched backward as the car comes to a halt. These requirements are met very completely by the electric brake mentioned above, for as the motors slow down the magnetizing current and consequently the brake pressure decrease and at the instant of stopping the pressure is almost nothing.

TABLE II.—Tests of Retardation by Brakes on Various Railway Trains. (Figures give the average of several observations of trains in actual service.)

Railway.	No. of cars.	Weight of train, net tons.	Type of brake.	Grade.	Speed in miles per hr.[1]	Distance of stop, ft.	Time of stop, secs.	Av'rage rate of retrdtn pr sec., miles per hr.	Equivalent brak'g effort, lbs. per net ton
Alley Elevated, Chicago	3	72	Auto air.	Level.	31	522	25	1.35	123
Metropolitan Elevated, Chicago	2	44	Straight air	"	19	181	13	1.46	133
Illinois Central R. R.	4	140	Auto. air	"	30	440	20	1.50	136
Illinois Central R. R.	4	140	"	"	40	1,086	37	1.08	98
Lake Street Elevated	2	44	"	.....	25	293	16	1.56	142
C. P. & E. Ry.	1	20	Electric.	Level.	30	220	10	3	275
Manhattan Elevated, New York	4	95	Vacuum.	"	22	387	24	.92	84

[1] On application of brakes.

$$\text{Braking effort per ton} = \frac{\text{Speed in miles} \times 91.5}{\text{Time stopping in seconds}} \text{ or}$$

Braking effort per ton = Rate of retardation × 91.5.

Feet per second = Miles per hour × 1.466.

Distance stopping in feet = Time stopping in seconds × speed in miles per hour × .733.

$$\text{Rate of retardation is given in miles per hour per second} = \frac{\text{Speed in miles per hour}}{\text{Time stopping in seconds}}.$$

LETTERS TO THE EDITOR.

A Lake Trip on an Ore Carrier.—Correction.

Sir: In the letter with the above title in your issue of Sept. 30 the statement of coal consumption as "seven tons per 1,100 miles," should read "seven tons per 100 miles."

Oct. 3, 1897. C. E. F.

Failure of a Highway Bridge Under a Traction Engine.

Sir: I send you a photograph of a bridge wreck which occurred about three miles south of Northwood, Ia., on Oct. 1. The bridge is of the combination type, having 14 × 14-in. pine floor beams. One of these beams broke about 3 ft. from the center, and the fracture, which was almost square across the grain, showed the timber to be partially rotten throughout the cross section, while two large knots extended through at the same place. The bridge

Wreck of Highway Bridge near Northwood, Ia., by a Traction Engine.

crosses the Shell Rock River, and was built about eight years ago. New stringers and floor plank had been put in recently, but the floor beams had not been renewed. Three men fell with the engine, a distance of 14 ft., but were not injured. Very truly yours, B. N. Moss.

Northwood, Ia., Oct. 8, 1897.

Use of Nut Locks.

Sir: What is the best nut-lock for use in railway work and on heavy agricultural machinery? Also, is there a nut-lock suitable for use on buggies and carriages?

Omaha, Neb., Sept. 23, 1897. D.

There are numerous makes of nut-locks used in railway work, most of which are washers given a spiral set so as to act as springs. Of this type, the Verona nut-lock (Verona Tool Co., of Pittsburg) is a good example, but there are many different styles made by other manufacturers. The Harvey grip-thread nut (J. H. Sternbergh & Co., Reading, Pa.) and the "elastic" nut (Elastic Nut Co., Milwaukee, Wis.) are lock nuts designed to avoid the use of separate nut-lock. For heavy machinery, the Western Wheeled Scraper Co. informs us that it uses the National lock washer (National Lock Washer Co., Newark, N. J.). As to agricultural machinery and carriages, the McCormick Harvesting Machine Co. states that it makes but little use of nut-locks, and has found nothing better than the old horned nut and spring key, while the Studebaker Bros. Mfg. Co. states that it has never used a nut-lock on any of its vehicles, and has not yet seen one which it considers practical without adding too much to the cost of the vehicle.—Ed.)

A Crisis in City Government at San Francisco.

Sir: I enclose a copy of the report of the Committee on Public Improvements of the Citizen's Charter Committee of One Hundred. The importance of the position of City Engineer as outlined may be interesting to your readers.

Last December, after the defeat of the proposed new charter, the Merchants' Association requested the Mayor-elect to appoint a committee, consisting of 100 citizens, to prepare the principles of a charter, and when the work was done to have a special election held to elect 15 freeholders in accordance with the state laws to prepare a charter. This the Mayor has done and the committee is at work. It has been decided to prepare a charter and nominate 15 candidates as freeholders from among the members. When the freeholders are elected this citizen's committee will present their charter to them for adoption, and then the people will vote on it some time next spring.

The freeholders' election will be held in November, and they will have 90 days in which to perform their work. The charter adopted by them will then be published for a month, and the people will then vote on its adoption or rejection. If adopted it will go in January, 1899, to the legislature for approval.

The members of the Committee of Public Improvements are as follows: Chairman, Irving M. Scott, President of the Union Iron Works; Secretary, Osgood Putnam, Attorney-at-law; A. S. Baldwin, Real Estate Agent and Second Vice-President of the Merchants' Association; C. E. Grunsky, Civil Engineer and Past President of the Technical Society, former Sewer Commissioner of this city, etc.; and the writer.

The Board of Supervisors (city council) of this city were removed from office last month for failing to comply with the law in establishing water rates a couple of months too late. The rates as fixed are seemingly favorable to the water company, but nevertheless stand, and are lawful. The officials, however, were removed for neglect of duty. They lacked promptness and decision. The Mayor appointed a new board, consisting of the four good men on the old board and eight prominent business men of the city in addition. As there was some question as to where the real appointing power lay, the Governor sent commissions to the same men.

The old men were thrown out of the city hall by the police on the order of the Mayor, and the two boards passed a tax levy for the fiscal year ending next September. All the city officials recognize the new board except the Auditor. He refuses to recognize either tax levy and was mandamused by the old board ("Solid Eight" they are called) to put their tax levy on his books. To settle the mandamus, and incidentally the right to the offices, the case was appealed to the Supreme Court and a decision is expected hourly. The court has been considering the matter for three days. The decision is expected to stand four to three (there are seven justices). Yesterday the betting was 5 to 1 in favor of the old board being returned, but to-day there are no bets being made. The long time being taken argues that there is a disagreement among the judges and makes it look as though the right of the men appointed might be good.

The stock of nearly all the street railways, water companies and gas and electric light and power companies went down a few points when the decision removing the supervisors was made public, and there was a further drop when the Mayor's appointments became public. They went upward, however, after the appeal was filed and were at par the day after the arguments were heard. Yesterday there was a slight advance, but to-day they are going down again and in the pool rooms there seems to be a hedging on the betting. Public business in the meantime is at a standstill and the city is in a bad state.

The President of the Merchants' Association, Mr. F. W. Dohrmann, was one of the new men appointed and he has been made chairman of the Street Committee. The writer has been appointed street and sewer expert by the new supervisors, pending the Supreme Court decision, of course. The expert heretofore has generally been a politician. It is the intention of the new men to give the city a business man's administration. Yours truly,

Ernest McCullough.

Consulting Engineer to the Mayor and to the Merchants' Association of San Francisco.

San Francisco, Cal., Oct. 2, 1897.

(The report mentioned as enclosed with the above letter contains the sections of the proposed new charter which relate to the board of public works, including the city engineer, who is to be appointed by that board. The charter gives the board control of all classes of city works, subject to some veto powers by the supervisors, or city council. The city engineer is to prepare all plans, specifications and estimates for the board, and no plans or specifications for any work done under the direction of the board shall be valid without the signature of the engineer. The board will consist of three members, appointed and removable by the mayor. One of the members must be a civil engineer of at least ten years' standing, as must also the city engineer.

As has been stated in these columns heretofore, San Francisco has long been in great need of reform in its public works and engineering departments. The adoption of the above provisions regarding its public works, coupled with the appointment of able men, rather than politicians, to the offices named, would be a long step in advance.—Ed.)

SHOULD THE GAGE OF RAILWAY TRACK BE WIDENED ON CURVES.

At the recent meeting of the American Railway Association, a report of which is published in another column, the committee on Standard Wheel and Track Gages presented the results of its inquiry into the practice of various railways of the United States in respect to widening the gage of track at curves. Briefly stated, the committee prepared a circular containing three questions, which it sent to the different railway companies with the request that the questions be answered fully. Something over a hundred companies answered the inquiry. The three questions were as follows: (1) Do you increase the gage of your track on curves, and, if so, how much? (2) By what ratio to the curvature do you make the increase? (3) What is your guiding reason for such increase and ratio? The replies of the more important railways to these questions are given in some detail further on, but they may be summarized here briefly, as follows:

No practice uniform enough to be regarded as established can be said to prevail among American railways in respect to the widening of the gage of track at curves. Some lines, which are characterized by their freedom from curvature, report that they widen the gage even on comparatively gentle curves, while others of equal or greater importance, and abounding in very sharp curves, distinctly oppose that method, and declare that experience abundantly justifies them in doing so. A common reason given for adhering to one gage throughout, is the complication involved by the introduction of switches, frogs and guard rails. Table I. summarizes in concise form the replies, some of which are given in more detail herewith:

In the following abstract of the replies received by the Committee to its circular, the reply of each railway is given in a separate paragraph, in which the name of the company and the mileage of line it operates come first, and are followed by the name and office of the person sending the information. Following the numerals (1), (2) and (3) are the answers to the questions, correspondingly numbered, as is noted above:

Ann Arbor: 600 miles; H. W. Ashley, Gen. Man.: (1) yes, on curves 3° and over; (2) 1-16 in., curves over 3° to 10° may be modified; (3) easier riding track.

Atlantic & Danville: 232 miles; Chas. O. Haines, Gen. Man.; (1) track is 4 ft. 9 ins. gage up to 8°; open gage ¼ in. from 8° to 10°, ⅜ in. from 10° to 12°; ½ in. from 12° to 16°; (2) about 1-16 in. per degree; (3) practice.

Baltimore & Ohio: 3,511 miles; W. M. Greene, Gen. Man.; (1) on light curves we make no allowance; (2) ¼ in. on 8° to 12°; (3) to give the track a little leeway in crowding around curve.

Beech Creek: 177 miles; A. G. Palmer, Supt.; (1) yes, up to ½ in.; (2) 1-16 in. to 1°, but not over ½ in, as where rule calls for more width, if gage is made width required by rule, wear of rail would soon make gage wider than is deemed advisable; (3) to save flange wear and to avoid spreading of track, and to reduce resistance to traction. The ratio is simply a mean which seems to fit the case, and gives the above result without widening the gage, so that a loose wheel or narrow tread might cause trouble.

Boston & Albany: 388 miles; W. R. Robeson, Gen. Supt.; (1) it has not been our practice to widen gage on curves.

Buffalo & Susquehanna: 112 miles; W. C. Pack, Supt.: (1) increase ¼ in. for each 5° curvature; (2) ¼ in. for each 5°; (3) prolongs the life of outer rail. Car trucks will bind.

Buffalo, Rochester & Pittsburg: 335 miles; Geo. E. Merchant, Asst. to Pres.; (1) on Rochester Division we spike curves as follows: 3° to 5°, inclusive, gage widened ¼ in.; curves 6° to 9°, inclusive, gage widened ½ in.; 10° to 16°, inclusive, gage widened ¾ in. On the Buffalo Division our curves are spiked as follows: Everything up to and including 5°, standard gage; 6° to 7°, inclusive, gage widened ¼ in.; 8° and upward, gage widened ½ in.; (2) the increase is not in direct ratio to the curvature; (3) we have never been able to decide which plan, as indicated in answer to question No. 1, is the better, for the reason that the type of locomotives used on one division differs somewhat from those used on other divisions.

Burlington, Cedar Rapids & North: 1,136 miles; Robert Williams, Vice-Pres.; (1) yes, on curves sharper than 3°; (2) about ⅛ in. to each degree over 3°; (3) to enable long trucks and engines of long, rigid wheel base to pass around sharp curves with less strain than would otherwise be possible.

Canadian Pacific: 7,219 miles; Thos. Tait, Man.; (1) yes, when curvature exceeds 4°; (2) ¼ in. from 4° to 6°; ⅓ in. from 6° to 8°; ⅜ in. from 8° to 10°; ½ in. from 10° to 12°.

Cape Fear & Yadkin Valley: 342 miles; J. W. Fry, Gen. Man.; (1) no.

Central Vermont: 646 miles; F. W. Baldwin, Gen. Supt.: (1) yes; (2) 5° to 8°, ¼ in.; 8° to 11°, ½ in.; over 11°, ¾ in.; (3) to enable locomotives to pass around curves without crowding rails to such an extent as to cause them to roll and spread.

Chicago & Alton: 849 miles; C. H. Chappell, Gen. Man.; (1) yes, on curves of 6° and upward; (2) 6° to 10°, ⅛ in.; 10° to 14°, ¾ in.; 14° to 18°, 1 in.; (3) to permit locomotives with long, rigid wheel base to use curves with safety.

Chicago & Northwestern: 5,030 miles; J. M. Whitman, Gen. Man.; (1) curve, 3° gage + 2-16 in.; 4° gage + 2-16 in.; 5° gage + 3-16 in.; 6° gage + 3-16 in.; 7° gage + 4-16 in.; 8° gage + 5-16 in.; 9° gage + 6-16 in.; 10° gage + 7-16 in.; 11° gage + 8-16 in.; 12° gage + 9-16 in.; 13° gage + 10-16 in.; (2) from gage + 4-16 in.; at 7° curves add 1-16 in. for each degree over 7°; (3) an average of observations.

Chicago, Milwaukee & St. Paul: 6,151 miles; W. G. Collins, Gen. Supt.: (1) yes, up to 4°, no increase; (2) over 4° and up to 6°, increase ¼ in.; over 6° and up to 8°, increase ½ in.; over 8°, increase ¾ in., which is the limit of increase; (3) to lessen the friction and prevent wheel flange and rail wear.

Chicago, Rock Island & Pacific: 3,574 miles; W. I. Allen, Gen. Man.; (1) yes, max. 9-16 in.; (2) below 4°, 4 ft. 8½ in., with max. at 10°; (3) that trucks may more readily run radial with curves.

Cincinnati & Muskingum Valley: 148 miles; C. M. Bennett, Supt.; (1) max. curve 4°, 0 in.; no spread of gage.

Cincinnati, Jackson & Mackinaw: 415 miles; F. D. Drake, Receiver; (1) yes, above 4° up to ½ in.; (2) ⅛ in. to the degree up to 8°; (3) to allow free curvature of the rigid wheel base on engines. As curvature increases the play of wheel gage decreases until a degree of curve of standard gage is reached when outside rail will bind on the extreme outer edge of flanges, causing damage to track by spreading. On ordinary car trucks such widening of gage is unnecessary. An allowance of ¾ in. is made in wheel gage which is sufficient for easy clearance.

Cleveland, Cincinnati, Chicago & St. Louis: 2,345 miles; Geo. W. Kittredge, Ch. Engr.; (1) on curves of 2° and over; (2) 1-16 in. for each degree over 3°; (3) to facilitate movement of trains and prevent wear of rails.

Cleveland, Lorain & Wheeling: 193 miles; W. B. Hanlon, Ch. Engr.: (1) yes; (2) .0026 ft. per degree of curve; (3) based on rigid wheel base of engine which requires ¾ in. on a 24° curve.

Cleveland Terminal & Valley: 76 miles; J. T. John-

TABLE I.—Condensed Summary of Practice of 104 American Railways in Widening Gage of Track on Curves.

Increase commencing with			Range of increase			Maximum increase.		
1° on 18 roads			1°, increase	1-32-in. to	¼-in.	¼-in. on	5	roads.
2° " 5	"		2° "	1-16-in. "	¼-in.	⅜-in. "	2	"
3° " 15	"		3° "	1-16-in. "	⅜-in.	2-5-in. "	1	"
4° " 10	"		4° "	1-16-in. "	¼-in.	½-in. "	30	"
5° " 16	"		5° "	1-16-in. "	½-in.	⅝-in. "	5	"
6° " 7	"		6° "	¼-in. "	½-in.	⅝-in. "	24	"
8° " 3	"		7° "	3-16-in. "	21-32-in.	9-16-in. "	2	"
9° " 1	"		8° and 9° "	¼-in. "	⅝-in.	15-16-in. "	2	"
10° " 2	"		10° to 12° "	¼-in. "	1-in.	1-in. "	8	"
13° " 1	"		13° "	¾-in. "	1-in.	1 3-16-in. "	1	"
21° " 1	"		14° to 20° "	¼-in. "	1-in.			
			20° " 30° "	¼-in. "	1 3-16-in.			

25 roads report no increase of gage on curves.

son, Gen. Supt.; (1) do not increase gage on main track curves, but do increase gage on heavy curves on spurs; (2) about 3-32 in. for every 2° above 14° curve; (3) by reason of rapid increase of middle ordinate or rail with curvature with a fixed wheel base, gage must be widened to attain results sought in coning wheels.

Columbus, Sandusky & Hocking: 318 miles; W. H. Mantz, Roadmaster; (2) ¼ in. for 6° and up to 9°; (3) we cannot hold track to gage on curve of 6° and over, so we increase the gage ¼ in. to overcome spreading of track.

Cornwall & Lebanon: 22 miles; A. D. Smith, Gen. Supt.; (1) no; (3) elevation of curves is all that is necessary.

Denver & Rio Grande: 1,666 miles; E. T. Jeffrey, Pres.; (1) we do not.

Dry Fork: 30 miles; F. K. Bretz, Gen. Man.; (1) we do not increase gage; (3) we tried increasing gage slightly on heavy curves, but now spike to neat gage and get better results.

Duluth & Iron Range: 154 miles; J. L. Greatsinger, Pres.; (1) yes; 1° to 2° widen ½ in.; 3°, ¼ in.; 4°, ⅝ in.; 5° and up, ½ in.; (2) 1-16 in. for every half degree from 2° to 5°; (3) experiments with coal and ore trains in daily service. The widening of gage on grades is dependent on the ratio of grade equation.

Durham & Charlotte: 15 miles; Frank D. Jones, Supt.; (1) we do not.

Elgin, Joliet & Eastern: 187 miles; C. H. Ackert, Gen. Man.; (1) yes, on curves of from 4° to 16°, beginning with 1-16 in. to 4° and increasing 1-16 in. for each degree thereafter to 16°; (3) to enable standard engines to round them without spreading rails or mounting them.

Erie: W. F. Merrill, 2d Vice-Pres.; (1) yes; (2) ¼ in. for every increase of 2° in the curvature, beginning at a 3° curve; (3) the guiding reasons are, to partially prevent the binding of the frames of locomotives and to make allowance for the rigidity of four or more wheeled trucks; the ratio is entirely based upon judgment.

Fall Brooks: 257 miles; G. R. Brown, Gen. Supt.; (1) 1° to 4°, inclusive, no increase; 5° to 9°, inclusive, ¼ in.; 10° to 14°, inclusive, ½ in.; 15° to 20°, inclusive, ¾ in.; (2) increase ¼ in. for each additional 5° of curvature; (3) to attempt to make the outside wheel of the forward axle of the car truck the only wheel whose flange presses strongly against the head of the rail, thereby reducing rail wear on the outside of the curve.

Fitchburg: 457 miles; A. S. Cheever, Ch. Engr.; (1) on sharp curves gage is increased ¼ in.; (2) gage on 4° curves and over is increased; (3) the reason for this increase is principally because the wear on outside rails and the rolling out of the rails tends to increase the gage, and it appears to us that considerable wear is saved by allowing the wheels to run a little loose on the sharper curves. It seems hardly practicable to establish a ratio for widening gage on curves, as we could not work very closely in practice. It is a constant fight with us to keep the sharp curves up to a 4 ft. 9 in. gage.

Florida East Coast: 415 miles; E. Ben Carter, Roadmaster; (1) no; (3) This road has 4 ft. 9 in. gage and standard gage trucks. The why of the "No" is obvious.

Frankfort & Cincinnati: 40 miles; Geo. B. Harper, Gen. Supt.; (1) do not increase gage.

Georgia: 307 miles; W. M. Robinson, Roadmaster; (1) do not increase the gage on curves less than 12°; over 12° increase ¼ in. to ½ in.; (2) 1-16 in. to each degree; (3) generally we would not increase the gage at all for any curvature (our trouble usually being to keep the gage from becoming too wide), except on account of the compromise wheel gage.

Georgia & Alabama: 450 miles; Cecil Gabbett, Vice-Pres.; (1) yes, as much as 1 in.; no increase up to 5°; from 5° up an increase of 1-16 in. to the degree until gage is 1 in. open, which is the max.; (2) from 5° to 20°, 1-16 in. to the degree up to 1 in.; 1 in. max. amount of open gage; (3) observation shows that if not put down open on sharp curves the gage will soon spread to be open, unless well braced, and in this case rail will wear badly.

Grand Trunk: 4,186 miles; Chas. M. Hays, Gen. Man.; (1) no; not sharp enough to require increase of gage, except in some station yards, to accommodate switch engines with long wheel base; (2) max. increase so far used has been ¾ in. on a curve of 200 ft. radius.

Hannibal & St. Joseph: Howard Elliott, Gen. Man.; (1) very rarely; do not think it necessary to increase gage of any curve up to 5°, but beyond that we increase gage up to a max. of 1 in.; (3) our reason for increasing gage on curves is for the purpose of permitting rolling stock having a long and rigid wheel base to pass curves easily.

Illinois Central: 3,540 miles; J. T. Harahan, 2d Vice-Pres.; (1) curves over 4° and under 6°, ¼ in. wide; over 6° and under 8°, ¼ in. wide; 8° and over, ½ in. wide; (2) arbitrary increase; (3) in order to allow trucks more readily to adjust themselves in going around curves.

Kansas City, Fort Scott & Memphis: 1,250 miles; Daniel Bontecou, Ch. Engr.; (1) yes; ¼ in. for curves over 4° and not exceeding 8°; (3) think some spread desirable on sharper curves, especially with reference to wheels which approach the M. C. B. limit of gage. Do not think it practicable to use a "rotio," but prefer to make as few changes of gage as can safely be done.

Lake Shore & Michigan Southern: 1,440 miles; W. H. Canniff, Gen. Man.; (1) yes, on curves over 3° 1-16 in. per degree; (2) 1-16 in. per degree; (3) to prevent to some extent the liability of a slewed truck mounting the rail or cutting it badly.

Lehigh Valley: 1,152 miles; Rolin H. Wilbur, Gen. Supt.; (1) yes; from 1-16 in. to 1⅛ in.; (2) about 1-16 in. for each degree; (3) to decrease the lateral pressure on the rails by the flanges of driving wheels of engines having a long, rigid wheel base.

Long Island: 374 miles; W. F. Potter, Gen. Supt.; (1) yes; 1 in. max.; (2) ⅛ in. for 8° curve, and ⅛ in. for each additional 4°, until max. of 1 in. is reached; (3) safety.

Louisville & Nashville: 3,171 miles; J. G. Metcalfe, Gen. Man.; (1) ¼ in. for 3° curve, ½ in. for 6° curve, etc.; (2) $\frac{36}{\text{radius}}$ of curve; (3) the longest rigid wheel base is assumed to be 17 ft.; gage is widened to correspond with middle ordinate of 17 ft. chord to avoid straining engines and damage to track.

Louisville, New Albany & Chicago: W. H. McDoel, Receiver; (1) yes; increase from 4 ft. 8½ ins. on curves up to 4° to 4 ft. 9½ ins. on 20° curves; (2) ¼ in. per degree; (3) we have all kinds of curves on this road, from fractional part of 1° up to 26°, some on level track and some on steep grades. After a test of one year we found that if all curves were spiked to 4 ft. 8½ ins. our engines would practically bring them to the gage as indicated in answer to first question.

Macon & Birmingham: 97 miles; Julian R. Lane, Gen. Man.; (1) no; we use 4 ft. 8½ ins. gage, which, with our max. curvature of 5°, we find amply wide for all purposes.

Maine Central: 821 miles; George F. Evans, Gen. Man.; (1) no.

Mexican Central: 1,955 miles; H. R. Nickerson, Gen. Man.; (1) yes; (2) the increase of gage is 1-16 in. to the degree of curve whose chords are 100 ft.; (3) our reason is that the chord from the outer wheels of a six-wheel truck leaves the center wheels 1-16 in. per degree from the gage.

Michigan Central: 1,642 miles; R. H. L'Hommedieu, Gen. Supt.; (1) we do not increase it.

Minneapolis & St. Louis: 608 miles; T. E. Clarke, Gen. Supt.; (1) yes; not more than ½ in.; (2) ¼ in. up to 6° curve and ½ in. from 6° to 18°; (3) to overcome rigidity of rolling stock; we are operating a curve of 30° in Minneapolis yard with an increase of ½ in. without difficulty.

Missouri Pacific: 5,351 miles; W. B. Doddrige, Gen. Man.; (1) theoretically by the versed sine of the angle made with the gage as radius and the elevation as the sine; (2) as indicated in answer to first question; (3) the guiding reason is to avoid excessive friction. The elevation of the outside rail is supposed to overcome the centrifugal force at prescribed velocities. In cases of increased speed over that used to ascertain elevation of outside rail the gage should be widened to relieve the additional friction which would accrue.

New England: 536 miles; F. E. Dewey, Gen. Supt.; (1) we make no change in our standard, which is 4 ft. 8½ ins.

New York, New Haven & Hartford (New Haven System): C. H. Platt, Gen. Supt.; (1) max. ¾ in., except in rare cases; (2) ¼ in. for 4° curve, and practically 1-16 in. for each additional degree of curvature; (3) the principal condition to be considered in the widening of gages on curves is the rigid wheel base of the locomotive. In cars the trucks adjust themselves to the curves, but in engines there is constantly a tendency to spread the gage in rounding a curve, owing to the rigid frame.

Norfolk & Western: 1,570 miles; J. M. Barr, Vice-Pres.; (1) yes; our standard gage up to 5° curve, 4 ft. 8½ ins.; curves of 6°, 7° and 8°, 4 ft. 8⅝ ins.; curves of 9°, 10°, 11° and 12°, 4 ft. 9 ins.; curves of 13°, 14°, 15° and 16°, 4 ft. 9¼ ins.; curves of 17° and 18°, 4 ft. 9⅜ ins.; curves of 19° and 20°, 4 ft. 9½ ins.; (2) 1-16 in. per degree over 4°; (3) engines and car trucks constructed on present standards will not round sharp curves without widening track when gaged 4 ft. 8½ ins. Flange wear and risk of derailment is reduced by widening gage on curves.

Northern Central: 382 miles; J. B. Hutchinson, Gen. Man.; (1) no.

Northern Pacific: 4,367 miles; E. H. McHenry, Ch. Engr., (1) yes; up to 4 ft. 9¼ ins.; (2) ¼ in. additional gage for each 3° over the first 3°; (3) to provide for chord ordinate with intermediate flanged drivers and obliquity of contact between rail and flange, forward and back of center line of wheels on all trucks. Ratio should vary with length of rigid wheel base. Adopted ratio is assumed mean of ordinary conditions.

Pennsylvania Lines West of Pittsburg: 1,076 miles; L. F. Loree, Gen. Man.; (1) on our main tracks the curvature does not exceed 8°, and on such curves we do not increase the gage; on sidings of small radii the gage is increased, varying from ⅛ in. to 1 in.; (2) no uniform rule is used on our lines; (3) on side tracks of short radii it is necessary to increase the gage somewhat to allow engines with long wheel base to pass around curves more freely.

Pennsylvania: 2,728 miles; J. B. Hutchinson, Gen. Man.; (1) no.

Philadelphia & Reading: 1,033 miles; Theodore Voorhees, 1st Vice-Pres.; (1) yes; up to ¾ in.; (2) ratio 1-16 in. per degree of curve; (3) to minimize train resistance on curves, due to binding of engine and truck wheels.

Philadelphia, Wilmington & Baltimore: 668 miles; J. B. Hutchinson, Gen. Man.; (1) no.

Pittsburg & Lake Erie: 174 miles; G. M. Beach, Gen. Supt.; (1) we do not.

Pittsburg & Western: 346 miles; L. P. Baker, Gen. Roadmaster; (1) 3 in. for 52° curve; (2) tangent, 4 ft. 8¼ in.; 4° or less, 4 ft. 8⅜ ins.; 4° to 12°, 4 ft. 9 ins.; 12° to 30°, 4 ft. 9¼ ins.; 30° to 52°, 4 ft. 9½ ins.; (3) rigid wheel base on locomotives; find by practical experience that curves cannot be held in gage unless above allowance is made.

Pittsburg, Bessemer & Lake Erie: 183 miles; Geo. W. Sykes, Engr. M. of W.; (1) from 0 to a max. of 1 in.; (2) $\frac{D}{30}$ — ins., where D is equal to degree of curve; (3) on the assumption that the increase in gage should vary inversely as the radius of curvature. We have found by experience that .5 in. in a 15° curve gives the best results. The above formula will apply to a 30° curve, beyond which use 1 in.

Rio Grand Western: 529 miles; A. E. Welby, Gen. Supt.; (1) no; (3) spike curves up to gage for the reason that in construction of rolling stock lateral motion is provided for, and to allow a wider gage on curves would mean severe side thrust on outside rail. Where a curve is spiraled and the elevation commences on the tangent, the side thrust is obviated, making it easier on track and equipment, decreasing the risk of track spreading and the perpetual regaging and respiking of track.

St. Paul & Duluth: 247 miles; L. S. Miller, Asst. Gen. Man.; (1) yes; ¼ in. to ½ in.; (2) under 4°, gage; 4° to 7°, ¼ in. wide; 7° to 10°, ½ in. wide; (3) increase of curvature decreases play of wheel-gage, and with sharp curves outside rail binds on outer edge of flanges and inside rail presses against flanges opposite wheels. Not appreciable in car trucks, but only in edge of long wheel base.

San Antonio & Aransas Pass: 687 miles; M. D. Monserratt, Gen. Man.; (1) 3° and upward, up to ½ in. increase; (2) 1-16 in. for each degree; (3) in order to keep the outside wheel from hugging the outside rail; otherwise with a flange or rail the slightest defect would tend to cause the wheel to climb. Where car has stiff trucks, also a little ease in gage of curve is beneficial.

Southern: 4,704 miles; W. H. Green, Gen. Supt.; (1) 1-16 in. per degree, with a limit of ⅛ in.; (2) 1-16 in. per degree; (3) experience has taught us that the gage will almost surely spread unless we widen it. Our engines and trains run around easier, and the engine can haul larger loads with the gage spread than it can with the regular gage. These widenings are above the gage we use—4 ft. 9 ins.

Southern Pacific (Atlantic System): 1,809 miles; W. G. Van Vleck, Man.: (1) 6° or less, 4 ft. 8⅛ ins.; over 6° and under 8°, 4 ft. 8⅜ ins.; 8° and under 10°, 4 ft. 8⅝ ins.; 10° and over, 4 ft. 8¾ ins.

Southern Pacific (Pacific System): J. A. Fillmore, Man.; (1) yes; (2) ⅛ in. to each 2°, the max. being ¾ in.; (3) following an old rule.

Western Maryland: 238 miles; J. M. Hood, Gen. Man.; (1) this company does not make any difference in the gage of its track between straight and curved portions. Unless it is certain that switch connections will never be made upon such curved portions of roads, the gage, we think, should not be increased, for if such connections are made, and the wider gage allowed to stand, trouble is very apt to result on account of the increased distance between frogs and guard rails. I have known guard rails to be torn from their positions by placing them at the usual distance from the track rail upon curves so widened. In the case of spring rail frogs, or where the wings are not very rigid, there would be liability to damage to the frog if the guard rails were securely held in position. If neither frog nor guard rail yielded, there would be danger of breaking or bending axles. In view of the instruction given by the Wharton Switch Co. to bring track to neat gage in applying their switch, it would not seem desirable, if practicable, to use a Wharton switch on a track widened for curvature. We have a few cases in which coal yard curves of 100 ft. radius or less are widened as much as 1 in. We do not, however, use engines upon these, nor make any connections with such curves.

Western New York & Pennsylvania: 635 miles; R. Bell, Gen Supt.; (1) the practice differs somewhat, but the rule is ⅛ in. per degree over 2°; nothing 2° and under; (2) ⅛ in. to each degree over 2°; nothing 2° and under; (3) the views of track supervisors are that the widening of gage on curves reduces flange wear on rails and ties and that track will keep in line and gage better. In fact, when sharp curves are spiked to gage the rails will spread until a gage is made which will allow the rolling stock to pass without excessive binding. If the track is not widened on sharp curves there is great danger to derailment.

West Shore: 495 miles; C. W. Bradley, Supt.; (1) yes; ¼ in. for 2° curve and 1-16 in. for each additional degree; (2) 1-16 in. for each degree of curvature; (3) we find that is requires 1-16 in. for each degree, as our track will spread if less allowance is made.

AN INSTRUCTIVE FAILURE OF A HIGHWAY BRIDGE ABUTMENT.

By W. L. Cowles, M. Am. Soc. C. E.*

Shortly after 8 o'clock on the evening of Wednesday, Sept. 29, the western abutment of the Washington St. Bridge, in Pottsville, Pa., collapsed, carrying with it the end of the western-most span. This bridge consists of nine spans, varying from 30 ft. to 85 ft. in length, and forms a viaduct over the Pennsylvania and Philadelphia & Reading railways. The spans are supported by iron trestle bents varying from 15 ft. to 32 ft. in height. The eastern end of the bridge terminates in a masonry approach, and the western end rests on an abutment 7 ft. high, which in turn was built upon an old retaining wall 25 ft. high.

The construction can be readily understood from Fig. 1, where the old retaining wall is seen on each side of the break, and the new abutment, somewhat broken, is directly under the end of the span which still rests upon it. The old retaining wall was built some 30 years ago, and the filling consisted of furnace-cinder and ashes. When the viaduct was built 10 years ago, instead of securing a known good foundation, the old retaining wall, of unknown or forgotten thickness at the base, and consisting of rubble laid dry, was, as a measure of supposed economy, accepted as a sufficient foundation, and an abutment of large stone laid in cement was placed on its top, and flanked by wing-walls 25 ft. long, of the same depth as the abutment, and rested on the old filling. A few weeks previous to the date of the accident the viaduct was adjusted and painted by an experienced contractor, who, in the course of his work, noticed that the old retaining wall was bulging out at a point about 18 ft. above its base, and was apparently about to fall forward. A careful measurement showed that at the point referred to the face of the masonry overhung the base over 9 ins., while the bridge seat retained its position nearly, evidently being held in place by the iron spans acting as a strut, although large cracks were discovered between the face of the abutment and the wing walls.

The wall was at once declared unsafe and a design was prepared by the city engineer providing for a new independent abutment with proper foundations. An old freight shed which stood close to the wall was removed, when it was discovered that the base of the retaining wall was barely on a level with the surface of the ground beneath the bridge, while the removal of the foundations of the freight shed exposed a face of earth below the base of the wall. The City Council promptly proceeded to shore up the end of the span resting upon the masonry as a measure of pre-

*Chief Engineer Bridge and Building Department, Pottsville Iron & Steel Co., Pottsville, Pa.

caution, and the contractor for the work started on the morning of Sept. 29 to clear away the loose stone and brick at the base of the wall, when the workmen, alarmed by evidence of movement in the wall above, refused to proceed and work was suspended. The street was closed and that evening, doubtless assisted by water from heavy rains of the preceding week, the wall fell, breaking at the point where the bulging was noticed, the lower portion fell forward, and was followed by the loose filling, upon which the upper portion slid down bodily. The cemented abutment held together as well as could be expected. The lessons with regard to true economy in securing substantial foundations are self-evident. Further lessons can be learned, however, with regard to footing for trestle bents and the construction of the bents themselves, from the effect of the accident upon the remainder of the structure.

When the abutment fell it moved well to the south, carrying the end of the bridge with it. This end-span, being a deck-plate girder and well braced, carried over the top of bent No. 1, producing an overhang of about 4 ft., as may be seen in Fig. 2. It will be noticed that there is only one panel of bracing in this bent, which is the highest one, and no bottom strut. The sway-rod is attached to the bottom of the post by a pin and double angle lug, riveted to a batten plate. The bed-plate of the post is anchored by four bolts to a limestone block 2 ft. square and 1 ft. thick, which rests on a larger footing, the only connection to which is the cement bed. The only resistance to overturning is, then, the weight of this limestone block and its adhesion through the cement to the footing below. At the top, the girders rest on brackets riveted to the posts, while the floor beams rest upon the tops of the latter, affording the minimum of transverse stiffness.

The effect on the connection at the bottom of bent No. 1 (hidden in Fig. 2 by some young man anxious for fame), due probably to the sudden wrench at this point, and to the small angle of the sway-rod with the vertical, was to tear out a piece of the batten plate, which remains attached to the double angle iron lug. The block is not moved from its bed, but the posts have turned on the southern edges of the foot-plates, drawing the northerly anchor bolts from the blocks.

In this case a bottom strut would not have helped matters much, but at the other bents, where the construction is identical, the only difference being in the heights, the utility of a strut is plainly evident, for at bent No. 2 the pedestal block under the north post is pulled 12 ins. toward the south, sliding on the footing beneath. At bent No. 3 there is a similar movement of 6 ins., at No. 4 a movement of 1 in., while at bent No. 5 the block has just started. The sway-rods pulling these blocks over are of course tight, while those crossing them are buckled.

In an unimportant short span highway bridge resting upon solid abutments there may be some excuse for omitting the end strut if the shoes are well anchored, but there can be none for failing to provide a bottom strut in a trestle bent 32 ft. high and 20 ft. wide, with only one panel of sway bracing, and the posts anchored to single blocks free to move upon the footing beneath. A bent of this height should also have an intermediate strut, and to provide proper anchorage the anchor-bolts should be much longer and built into the substructure.

The fallen span seems to be practically uninjured, but the posts of bent No. 1 are badly twisted and torn at the top, and the bottom chords of span No. 2, which is a deck lattice girder, are somewhat buckled, not, however, more than can probably be taken out when the pressure from the fallen span is removed.

Fig. 1.—View of Broken Retaining Wall which Supported the Abutment.

Fig. 2.—View of Trestle Bent Distorted by the Swing of the Bridge to One Side.

FAILURE OF A MASONRY ABUTMENT SUPPORTED BY A WEAK RETAINING WALL, WASHINGTON ST. BRIDGE, POTTSVILLE, PA.

THE ADVANTAGES OF MALLEABLE IRON FOR CAR CONSTRUCTION AND REPAIRS.*

By Eugene Chamberlin.

Without entering into the cause that has occasioned the largely increased use of malleable iron in car and locomotive construction and repairs within the past few years, a few practical facts with relation to the benefits obtained from its general use may prove interesting. First, and of greatest importance to railroad companies, is its economy as compared with grey iron castings for similar uses. This may seem a startling statement to make and appear not to be borne out by the prices rendered by malleable iron manufacturers against purchasers; but when we consider the reduced weight of from 40 to 60% per pattern, and the greatly increased strength and total reduction of dead weight per car of malleable iron as against grey iron, we discover that the original investment begins to declare dividends to the purchaser very soon after castings are once applied. This is further emphasized by the fact that when malleable iron castings are once applied they "stay where they are put," and are not removed on account of breakage within a very brief period after application.

Theories and general statements are but inadequate proofs unless supported by facts, and I am permitted to quote from a very complete and carefully compiled record of a prominent trunk line (Erie R. R.) which has been using malleable iron in car and locomotive construction and repairs for a number of years and is to-day using it almost exclusively on cars, as follows:

For every dollar's worth of grey iron castings purchased for a stated period of years and used in car and locomotive construction and repairs, more than 59½ cts. of same at original value have been removed on account of breakage and consigned to the scrap-pile, and during an equal period, for every dollar's worth of malleable iron cas... purchased and applied to cars and engines, less than 3½ cts. at its original value have been removed on account of breakage and consigned to the same locality.

Now, as to the question of dead weights: With a reduction of from 1,300 to 1,500 lbs. per car of 60,000 lbs. capacity (depending upon design) as compared with grey iron castings, we readily see that an extra car might be easily added to each train of 15 cars without placing any additional tax upon the motive power. Or, assuming that a railway company is deriving a revenue for carrying 20,000 lbs. of freight instead of deadheading an equal amount of grey iron castings, could not this revenue, in all fairness, be credited to the original cost of malleable iron castings as the producing cause? This does not occur once a year or once a month, but is in evidence on every trip of the train, thus adding strength to the argument we seek to advance and creating a revenue for the company from an apparently undiscovered source. Again, if we take what statistics show it costs a railway company per ton per mile to haul freight and a car will average say 20 miles per day for a year and there is a reduction in dead weight of 1,300 to 1,500 lbs. per car on account of using malleable castings, a simple calculation with the foregoing figures as a basis will demonstrate that the company is deriving a yearly revenue equal to nearly one-half of the original cost of malleable castings used on car. Add to this a reduction in the stock of castings necessary for a company to carry on account of less breakage of malleable iron as against grey iron castings, and we secure a sum total that would seem to recommend malleable iron castings for general use in car and locomotive construction and repairs.

Grey iron castings can at all times be readily replaced by those of malleable iron for the reason that the original outlines of patterns are maintained, the only change being a reduction in thickness of metal, and additional strength given by ribbing and building up in detail, and consequent lessening of dead weights. The reputable manufacturer of malleable iron, furthermore, stands ready with a competent corps of draftsmen and pattern makers to embody the ideas of any master mechanic or master car builder in a change of patterns from grey iron castings to those of malleable iron for use in locomotive and car construction and repairs, and at the same time to offer, if desirable, a few valuable hints as to the distribution of metal to give the greatest strength to the several patterns.

*Abstract of a paper read before the Central Railway Club Sept. 10, 1897.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

The fourth annual convention of this association was held Oct. 5 to 8, at Nashville, Tenn. The meeting was called to order by President August Herrmann at 10:30 a. m. Tuesday. The usual addresses of welcome by city officials were delivered, and were responded to in behalf of the society by the President, after which the routine business of the convention commenced and was continued to the close of the session. The afternoon session was exclusively devoted to questions of street paving, and after the following papers were either read in full or by title there was a general discussion upon the subjects treated:

"Grooved vs. Plain Sides for Street Paving Blocks," by W. L. Glazier, City Engineer, Newport, Ky.; "The Practicability and Advisability for a City Like Minneapolis to Lay and Maintain Its Own Asphalt Pavements," by F. W. Cappelen, City Engineer, Minneapolis, Minn.; "Results of One Year's Work with a Chemical Laboratory for Testing Asphalts," by Nelson P. Lewis, Engineer of Street Construction and Maintenance, Brooklyn, N. Y.; "Asphalt Pavements," by Andrew Rosewater, Omaha, Neb.; "Paving-Brick Tests," by M. L. Holman, Water Commissioner, St. Louis, Mo.; "Progress in Street Paving," by S. J. Hathaway, President City Council, Marietta, O.; "A Few Considerations Regarding Modern Wood Pavements," by M. A. Downing, Chairman Department Public Works, Indianapolis Ind.; "Rumbling in Brick

Pavements," by Ernest Adam, Engineer Street and Sewer Department, Newark, N. J.; "Asphalt Street Repairs," by A. N. Milner, Street Commissioner, St. Louis, Mo.

The evening session was occupied in the reading and discussion of the following reports and papers:

Report of Committee on Electric Street Lighting, by John A. Cabot, Chairman, Cincinnati, O., and also by the same a paper on "An Ideal System of House-Top Construction;" report of Committee on Taxation and Assessments, by R. E. Hornor, Chairman, Parkersburg, W. Va.; "Municipal Taxation," by R. E. Hornor, President Board of Trade, Parkersburg, W. Va.; "Observations on General Taxation and Special Assessments," by N. P. Lewis, of Brooklyn, N. Y.

At the morning session on Wednesday the report of the Committee on Street Paving was read by A. D. Thompson, City Engineer, of Peoria, Ill., and discussed briefly, after which the report of the Committee on Sewerage and Sanitation was read by Geo. H. Frost, of Plainfield, N. J., the subject of the report being "The Purification and Disposal of Sewage." Papers on water supply and purification were then read, the subjects being "Locating and Removing Sources of Pollution from a Surface Water Supply," by M. A. Sherrard, Newark, N. J., and "Filtration of Davenport, Ia., Water Supply," by E. W. Boynton, of that city.

The President announced the officers elect for the ensuing year, the principal ones being: President, Harrison Van Duyne, Newark, N. J.; Secretary, D. L. Fulton, Allegheny, Pa., re-elected; Treasurer, John L. Kennedy, Nashville, re-elected.

Washington, D. C., was announced as the next place of meeting of the society. The afternoon was spent at the Exposition.

The morning session of Thursday was devoted to reading in full or by title and discussing the following papers: Report of the Committee on Disposition of Garbage and Street Cleaning, by Dr. J. L. Hess, of Cleveland, O.; "Disposition of Garbage," by Dr. Kempster, Health Officer, Milwaukee, Wis.; report of Committee on City Government and Legislation, by Chas. Carroll Brown, Bloomington, Ill.; also by the same, "The Method of Appointment of Boards of Public Works and Engineers, and Checks Upon Their Action;" report of Committee on Review, by Lansing W. Beach, Chairman, Washington, D. C.

The afternoon was spent in visiting the Belle Meade Stock Farm, where the famous horses Gen. Longstreet, Iroquois, Luke Blackburn and others familiar to racing annals were exhibited. At 9 p. m. there was a banquet at the Casino on the Exposition grounds.

On Friday the report of the Committee on Water-Works and Water Supply was read by E. H. Keating, City Engineer of Toronto, Canada, and reports of special committees and papers were also presented as follows:

"Abolishing Railroad Crossings in Cities," by H. J. Stanley, Chairman, Cincinnati, O.; "Electrolysis," by F. W. Cappelen, Chairman, Minneapolis, Minn.; "Coating of Cast Iron and Steel Riveted Pipes," by Geo. H. Benzenberg, Chairman, Milwaukee, Wis. Also papers as follows: "Tests of Coatings for Steel Water Pipe," by F. W. Cappelen, City Engineer, Minneapolis, Minn.; "The Latest Method of Electrolysis Prevention," by Harold P. Brown, Electrical Engineer, New York city; "The Experience of the City of St. Louis, Mo., with Respect to Municipal Street Sprinkling," by Robert E. McMath, President Board of Public Improvements, St. Louis, Mo.; "School Inspection As a Means of Preventing Contagious Diseases," by Dr. J. M. Withrow, Health Officer, Cincinnati, O.; "Bicycle Paths," by L. W. Rundlett, City Engineer, St. Paul, Minn.

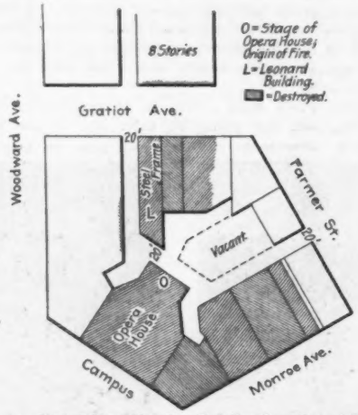


Fig. 1. Sketch Map Showing Relative Location of Buildings Burned in Detroit, Mich. Fire of Oct. 7, 1897.

THE CALUMET DRAINAGE DISTRICT, now proposed, will be adjacent to the southern boundary of the present Chicago drainage district, and will have a canal extending westward from the Calumet River to the Chicago main drainage channel, joining the latter near "The Sag." The boundaries of the new district are somewhat in dispute, but the matter will probably be submitted to the vote of the residents of the district on Nov. 2. The canal is estimated to cost about $7,000,000.

BEHAVIOR OF NON-FIREPROOF STEEL BUILDING CONSTRUCTION IN THE DETROIT, MICH., FIRE.

By Frank M. Dunlap, M. Am. Soc. M. E.*

In order to forestall in a measure any discussion of steel-framed structures based on the supposed fireproof qualities of the Leonard Building, which was destroyed by fire in Detroit, Mich., on the morning of Oct. 7, I give herewith a diagram of the premises destroyed, showing the exposure of the Leonard Building, and a photograph of the rear of the same building, taken a few hours after the fire, and showing in a general way the damage done.

The fire started shortly after midnight, and about the first that was known of it was a series of sharp explosions, which blew out the rear wall of the stage, only 20 ft. from the rear of the Leonard Building. The explosions are supposed to have been the bursting of the gas tanks for the calcium lights, of which several had been in use

Fig. 2.—VIEW SHOWING FRONT OF OPERA HOUSE AND REAR OF THE STEEL-FRAMED LEONARD BUILDING BURNED IN THE DETROIT FIRE.

*1310 Majestic Building, Detroit, Mich.

at the evening's performance. The fire had, therefore, gained great headway before the fire department arrived. Either the force of the explosions blew in the windows and wall of the Leonard Building, or the heat broke the unprotected windows. It is impossible to say which was the case, but the result is the same in either. The fire had almost immediate access to the whole ten stories filled with furniture, new and old, and the oils and varnishes accompanying such a stock. Driven on by the fierce heat of the open fire in the opera house stage, and fed by the highly inflammable contents of the building, the fire was an exceedingly hot one, and fighting it was made very difficult by the shape and location of the buildings. The principal wonder is not that the building was thoroughly gutted, but that even the frame is left standing in nearly its original shape, especially when the shape, size and construction of the building are taken into consideration.

The Leonard Building was ten stories high, 26 ft. by 110 ft. on the ground, and each story or floor was in one room, or practically so. The frame was of steel, well wind braced with knees at the joining of columns and floor beams, and, I am told, with some diagonal rods in the roof, and the floor systems, although these are not apparent at present. The floors proper were of 2-in. pine plank, tongued and grooved and laid on beams spaced 4 ft., c. to c. The architects of the building informed me that they wished to put in double floors, with a sheeting of asbestos paper between the 2-in. floor and a hardwood floor above, but it would cost too much, and even the maple flooring was dispensed with, except where needed for finish. The interior columns were covered with hollow tile, as were the principal floor members, but I am told that the covering did not extend to every part of the steel work, and it is not possible at present to say what was and what was not protected.

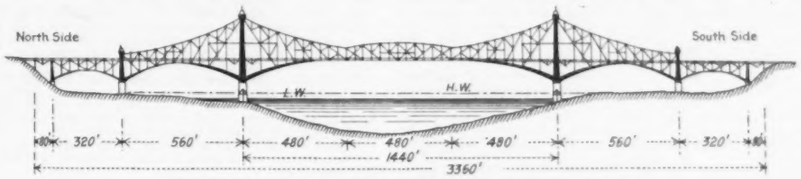
The protograph shows the condition of the outer wall fairly well. The columns and many of the floor beams and girders are still straight as nearly as can be told from the nearest inspection I have been able to make. The girders carrying the walls and most of the roof framing are too badly twisted to be of any further use, but the whole stands apparently solid, and it is claimed that much of it will be fit to use again. The front wall, on Gratiot Ave., is intact, excepting some chipped terra cotta work.

The remaining buildings involved were of the ordinary brick shell and wooden floor system type, some of them very old. Those facing Monroe Ave. were completely destroyed, as is also the opera house. The front walls and part of the floors on the corner of Monroe Ave. and Campus Martius are still standing. Of the buildings next the Leonard Building on Gratiot Ave., one was burned all out and another partly burned and partly crushed by falling walls. The eight-story building across Gratiot Ave. suffered the loss of most of the glass in its front and was also injured some from water, but there was no fire in it. The stores facing Woodward Ave. and across the 20-ft. alley were injured somewhat by fire on their roofs and rear walls and considerably by water, but no very great amount in the aggregate. The wind lay for most of the time approximately across Monroe Ave., or between that and parallel to Woodward Ave.

Considering the character and contents of the building and the punishment it received, the steel work has stood up very well, and to use the expression of a well-known engineer, "it gives one a heap of confidence in what a good one will do."

PROPOSED BRIDGE ACROSS THE ST. LAWRENCE RIVER AT QUEBEC.

There has for some years been a project to build a railway bridge across the St. Lawrence River, near Quebec, in order to connect the several railway systems on both sides of the river, and, it is said that the outlook is now favorable for the carrying out of the project. The matter is in the hands of the Quebec Railway Co., of which Mr. E. S. Shaw, of Boston, Mass., is the engineer, and Mr. Ulrich Barthe, of Quebec, is the secretary. The project dates from 1849, when an act was passed granting a subsidy for a line from Halifax to Quebec, and it was later expected that the Grand Trunk Ry. would build its line from Portland, Me., to Quebec, and thence along the north shore to Montreal. Instead, however, the line was built direct to Montreal, involving the construction of the great Victoria tubular bridge, and later on the Canadian Pacific Ry. built a north shore line from Montreal to Quebec. The Intercolonial Ry. was then expected to cross the river and have a terminus in the city, but its present terminus is at Levis on the opposite side of the river, and it is now figuring on an extension along the south shore to Montreal. When the Canadian Pacific Ry. was being built it was thought at one time that it would start from Quebec, with a bridge across the St. Lawrence to effect connection with the Intercolonial Ry. for a through line from Halifax to the Pacific, but Montreal was made the eastern terminus. Again, a few years ago, when the same road was arranging for a line eastward from Montreal to an Atlantic coast port, it was thought that the Quebec line would be utilized and that this would be effected by utilizing the Quebec line and simply building a bridge across the St. Lawrence at Quebec, instead of which the river was bridged at Lachine, above Montreal, and a line built through Canadian and United States territory to St. John, N. B.



ELEVATION OF THE PROPOSED QUEBEC RAILWAY BRIDGE.
E. S. Shaw Engineer.

Numerous sites and plans have been proposed for the St. Lawrence bridge at Quebec, but, according to the plans of the present company, it will be located about five miles above the city, near the mouth of the Chaudiere River, where the St. Lawrence is narrower than at any other point below Montreal. It will be of the cantilever type with a channel span of 1,440 ft. As shown by the accompanying diagram there will be at each end a short deck span of 80 ft., and a deck span of 320 ft. extending to the anchor piers of the cantilevers. The shore arms of the cantilevers will be 560 ft. long and the channel arms each 480 ft. long, with a suspended span of 480 ft. The piers will be founded on rock in about 40 ft. of water, and will be carried up to about 50 ft. above high water. The foundations will be sunk by means of pneumatic caissons, each pier consisting of two separate caissons supporting two masses of masonry, the tops of which will in turn support the bases of the steel towers, the separate piers being connected by a masonry arch. The caissons will be octagonal in plan, with extensions up and down stream to support the ice breakers of the piers. The caissons will probably be constructed of timber faced with steel on the cutting edges and on the vertical edges of the ice breakers. The masonry piers will be of granite or limestone, octagonal in plan, the diameter parallel with the stream being somewhat greater than the transverse diameter. The bridge will have a double track on the center of the floor (28 ft. width of roadway) and a 15-ft. roadway on each side (on the same level) for carriages and pedestrians. It is possible that a service of electric cars may be run over this bridge, either on the roadways, or on the main tracks, between the times of the regular trains, as is proposed to be done on the new Victoria Bridge at Montreal. The shores are high, so that there will be no difficulty in the approaches for the high level; the bridge is to have a headway of 150 ft. at the center.

The estimated cost is $3,000,000 or $4,000,000 including the railway connections, and the estimates which have been prepared show a probability of sufficient traffic to make the work a paying investment. It is expected that 50% of the cost will be granted by the Dominion government, Provincial government and city government, leaving the rest to be raised by an issue of bonds, which it is thought can be placed in Europe. The figures upon which this estimate has been based have been allowed by the department of railways and canals, and it is thought that if advantage could be taken of the present dull times, a competition for the contract would result in bringing the cost below the estimate of $3,000,000. The cost of 8½ miles of single track railway to connect each end of the bridge with the Grand Trunk Railway (at the Chaudiere curve) and the Canadian Pacific Railway (near the old Quebec & Lake St. John Ry. junction) will probably amount to $360,000, exclusive of the land damages. If it should be found expedient to connect with the Quebec & Lake St. John Ry. for terminal purposes and only connect with the Canadian Pacific Ry. outside the city for the transfer of its cars, it will be necessary to build about four miles of additional track to connect with the former line at Hedleyville and avoid passing through expensive property in the city. This four miles of line would probably cost $80,000, including land damages. For the present, however, the necessary expenses would be confined to the work of the bridge proper and a short distance on each side to insure proper connections, so that it is considered that under present conditions, the estimate of $3,000,000 would cover the cost of the bridge and the rail connections immediately necessary.

There will be six railways connected by this bridge: Three on the north side (Canadian Pacific Ry., Quebec & Lake St. John Ry. and Quebec, Montmorency & Charlevoix Ry.), and three on the south side (Grand Trunk Ry., Quebec Central Ry., and Intercolonial Ry.). There would also be, later on, two other lines; 1. The Great Northern Ry., which when completed, will form a direct line from Quebec to Parry Sound; and, 2. The new Drummond County Ry., on the south side. The present traffic is estimated at 228,743 tons of freight, and 199,000 passengers per year. This exchange of traffic between the railways and the city of Quebec is very expensive and inconvenient. The cost to the railway companies or to the merchants of Quebec is about 3 cts. per 100 lbs. in summer (including the ferry charge of 2 cts. and a charge for handling from the cars to the ferry on the south shore). In winter this charge is about double, making an average charge throughout the year of, say 80 cts. per ton, or $182,995. For passengers the railway companies pay an average of 5 cts. per passenger in summer and 10 cts. in winter, in addition to paying for the transfer of baggage and express matter, so that the average is estimated at 8 cts. per passenger, or $15,924 per year. The total amount thus paid for the exchange of freight and passengers by ferry between the south shore and the city of Quebec is about $198,920, which is a charge upon the commerce of the city, without giving a satisfactory manner of handling the traffic. The estimated traffic over the bridge (northbound and southbound), is 207 cars (passenger and freight) per day, or 64,791 loaded cars per year of 313 working days, which, at an average toll of $3 per car would yield a revenue of $194,373 per year, which is considered to be a conservative estimate.

The general dimensions of the proposed bridge are as follows:

Total length of bridge	3,400 ft.
Width of river at high tide	2,440 "
Width of river at low tide	1,850 "
Range of tide	20 "
Max. depth of channel at low tide	180 "
Height of cliffs on the north shore	165 "
Height of cliffs on the south shore	140 "
Center span, c. to c. of towers	1,140 "
Clear span at low tide	1,400 "
Length of shore arms of cantilevers	560 "
" channel arms of cantilevers	480 "
" suspended span	480 "
" shore spans	320 "
Clear headway at center, above high tide	153 "
Elevation of track, at center, above high tide	160 "
" top of masonry piers above high tide	50 "
" top of cantilever towers above piers	300 "
Depth of cantilevers at ends	60 "
Depth of suspended span at center	80 "
Width of superstructure at top of piers	90 "

SEMI-ANNUAL CONVENTION OF THE AMERICAN RAILWAY ASSOCIATION.

The semi-annual meeting of this Association, held Oct. 6, at the Holland House, New York city, was well attended. The executive committee reported 243 companies with 156,688 miles of road as now represented in the Association. The subject of large car construction, which had been referred to the Association by the Joint Traffic Association, was presented by the executive committee as follows:

Whereas, The indiscriminate construction of cars of extraordinary and unwieldy dimensions introduces into railroad operation an unsafe and expensive factor, and also tends to unsettle rates; therefore,

Be it resolved, That this Association endorses the majority report on "large car construction," contained in Report No. 265 of the Commissioner of the Joint Traffic Association of March 15, 1897. In its opinion any effort to control the dimensions of cars through the operating departments alone would be futile, and this Association, therefore, regards it as vital that traffic officers should at once take the necessary steps to carry out the recommendations of that part of the report which relates to classifications and minimums, viz.:

Your committee finds no difficulty in reaching the conclusion that the remedy for the evils from which we now suffer by reason of the varied sizes and capacities of freight cars, and the tendency to increase dimensions and depart from uniformity, rather than adopt practices tending to uniformity, must be applied by the traffic officers through classifications and minimums. We your committee earnestly urge that the respective Associations take such action as will bring about a material modification of the existing practice, to the end that such minimums may be established as will equitably adapt themselves to the different capacities of the cars now in service. We feel that better immediate results may be accomplished in this direction than in any other.

The preamble and resolutions were adopted by the Association without change.

At the last meeting the president was authorized to appoint a committee of five to examine and report upon the metric system and whether it should be adopted by the railways in the United States. The committee appointed consisted of Messrs. W. F. Allen, Secretary of the Association; Theo. N. Ely and L. F. Loree, of the Pennsylvania; C. W. Buchholz, of the Erie, and E. C. Carter, of the Chicago & Northwestern. At the meeting the committee presented a preliminary report in which they gave at much length the history of the metric system and of other standards of weights and measures, and advised all railway officers to familiarize themselves with the subject and be prepared to vote at a future date upon the advisability of the adoption of the metric system. In its present report the committee refrained from making any other recommendations.

The report of the Committee on Train Rules was presented, giving discussions upon several disputed points in the interpretation of the rules for operating trains by telegraphic orders. The committee also reported that it was revising the standard code, and had made substantial progress.

The Committee on Car Service reported the following resolution, the adoption of which was postponed until the next spring meeting:

Resolved, That the rules governing the loading of lumber and timber on open cars and loading and carrying structural materials, plates, rails, girders, etc., as revised by the Master Car Builders' Association in June, 1897, be made the rules of this Association.

The committee also presented for the information of the Association the resolutions adopted by the National Association of Car Service Managers at its convention held in Boston in June last. This resolution was, in substance, that agents should be held responsible to the accounting department for car service earnings (demurrage charges) exactly as they were held accountable for freight charges, and asked the concurrence of the American Railway Association. The committee advised that this concurrence be granted.

On the subject of mileage of cars on car ferry lines the committee asked for more time for investigation.

The excess allowable over the marked capacity of freight cars was referred to as a matter which had been investigated; but the committee recommended no change in the Association's rules on this matter.

The following was presented by the Joint Committee on Interlocking and Block Signals as a proposed standard code for the Association. The draft was presented for discussion by the members and final adoption at a later date:

INTERLOCKING.

Definitions.

Interlocking.—An arrangement of switch, lock and signal appliances so interconnected that their movements must succeed each other in a pre-determined order.

Interlocking Plant.—An assemblage of switch, lock and signal appliances, interlocked.

Interlocking Cabin.—A building from which an interlocking plant is operated.

Interlocking Signals.—The fixed signals of an interlocking plant.

Home Signal.—A fixed signal at the point at which trains are required to stop when the route is not clear.

Distant Signal.—A fixed signal of distinctive character used in connection with a home signal to regulate the approach thereto.

Dwarf Signal.—A low fixed signal.

Requisites of Installation.

1. The interlocking of signals with switches, locks, railroad crossings, or drawbridges, so that a clear signal cannot be given unless the route to be used is clear and stop signals displayed for all conflicting routes.

2. The interlocking of switches, locks, railroad crossings, drawbridges and signals through levers, or their equivalent.

3. Interlocking levers, or their equivalent, by which switches, locks and signals are operated.

4. Switches of prescribed form, the indications given by two positions, and in addition at night by lights of prescribed color.

5. The apparatus so constructed that the failure of any part directly controlling a signal will cause it to give the normal indication.

6. Signals, if practicable, either over, or upon the right of, and adjoining the track to which they refer.

7. Semaphore arms, that govern, displayed to the right of the signal mast as seen from an approaching train.

8. The normal indication of home signals—STOP (of distant signals—CAUTION).

9. The apparatus so constructed that the failure of any part directly controlling a switch or lock will prevent the display of the clear signal.

10. Facing point locks, for all facing point switches in main routes.

11. Detector bars, or their equivalent, for all facing point switches in main routes.

12. Pipe, or its equivalent, compensated for changes in temperature, for connecting levers, in mechanical interlocking, with switches and locks.

13. Latch locking or its equivalent.

14. The established order of interlocking such that:

A clear home signal cannot be displayed until derails or diverging switches, if any, in conflicting routes are in their normal position, and the switches for the required route are set and locked:

The display of a clear home signal shall lock all switches and locks in the route as far as the point to which such signal gives permission to proceed, locking all opposing or conflicting signals and releasing the corresponding distant signal, where such signal is used:

Where distant signals are used, the display of a clear distant signal shall lock the home signal in the clear position.

15. Interlocking and Block Signals, interconnected, where both are operated from the same cabin.

Adjuncts.

The following may be used if desired:

(A) Dwarf signals.

(B) Distant signals.

(C) Bolt locking of switches, or its equivalent, by signal connections.

(D) Derails, or diverging switches, for railroad crossings, drawbridges, junctions, and in sidings connected with the running tracks: Normal position—Open.

(E) Electric locking of derails, facing point switches and drawbridges so that they cannot be opened after a train has passed the clear distant signal until the train has passed over them.

(F) Detector bars, or their equivalent, at railroad crossings and junctions.

(G) Repeaters or audible signals to indicate the position of signals to the signalmen operating them.

(H) Annunciators indicating the approach of a train, or for other purposes.

(J) Route Indicators.

(K) Torpedo Placers.

Rules for Interlocking.

801. Interlocking signals, unless otherwise provided, do not affect the rights of trains under the time table, or train rules; and do not dispense with the use or the observance of other signals whenever and wherever they may be required.

802. Signals.—Home Signals.

Signal.	Occasion for use.	Indication.	Name.
Color.	The signal will be displayed when	For enginemen and trainmen.	As used in rules.
(a) Red.	Route is not clear.	Stop.	Stop signal.
(b) ——.	Route is clear.	Proceed.	Clear signal.

Where the semaphore is used, the governing arm is displayed to the right of the signal mast as seen from an approaching train, and the indications are given by positions:

Horizontal as the equivalent of (a).

Vertical or diagonal ——* as the equivalent of (b).

Distant Signals.

Signal.	Occasion for use.	Indication	Name.
(c) ——.	Home signal at (a).	Proceed with caution to the home signal.	Caution signal.
(d) ——.	Home signal at (b).	Proceed.	Clear signal.

Where the semaphore is used, the governing arm is displayed to the right of the signal mast as seen from an approaching train, and the indications are given by positions:

Horizontal as the equivalent of (c).

Vertical or diagonal ——* as the equivalent of (d).

*Angle above or below the horizontal.

Signalmen.

803. The normal indication of Home Signals is (a), as above; (of Distant Signals (c), as above.)

804. Levers, or other operating appliances, must be used only by those charged with the duty and as directed by the rules.

805. Signal levers shall be kept in the position giving the normal indication, except when signals are to be cleared for an immediate train or engine movement.

806. When the route is clear the home (and distant) signals shall be cleared sufficiently in advance of approaching trains to avoid delay.

807. Signals shall be restored to the normal indication as soon as the train or engine for which they were cleared has passed ——.

808. If necessary to change any route for which signals have been cleared for an approaching train or engine, switches must not be changed or signals cleared for any conflicting route until the train or engine, for which the signals were first cleared, has stopped.

809. No attempt shall be made to move a switch or facing point lock when any portion of a train or an engine is standing on or closely approaching the switch or detector bar.

810. Levers must be operated carefully and with a uniform movement. If any irregularity, indicating disarranged connections, be detected in their working the signals shall be restored to the normal indication and the connections examined.

811. Signalmen must observe, as far as practicable, whether the indication of the signals corresponds with the position of the levers.

812. If any signal fails to work properly its operation shall be discontinued and the signal secured so as to give the normal indication until repaired.

813. If necessary to discontinue the use of any fixed signal, hand signals must be used and ——— notified.

814. If there is a derailment or if a switch is run through, or if any damage occur to the track or interlocking plant, the signals shall be restored to the normal indication, and no train or switching movement allowed until all parts of the interlocking plant and track liable to consequent injury have been examined and are known to be in a safe condition.

815. If necessary to disconnect the switch from the interlocking apparatus the switch must be securely fastened.

816. During storms or drifting snow special care must be used in operating switches. If the force whose duty it is to keep the switches clear is not on hand promptly when required, the fact shall be reported to ———.

817. During the cold weather the levers must be moved as often as may be necessary to keep connections from freezing.

818. If any electrical or mechanical appliance fails to work properly ——— shall be notified and only duly authorized persons allowed to make repairs.

819. Signalmen will be held responsible for the care of the cabin, lamps and supplies; and of the interlocking plant, unless provided for otherwise.

820. Signalmen must not make or allow any unauthorized alterations or additions to the plant.

821. When switches or signals are undergoing repairs, signals must not be given for any movement which may be affected by such repairs until it has been ascertained from the repairmen that the switches are properly set for such movements.

822. Lights in interlocking cabins shall be so placed that they cannot be seen from approaching trains.

823. Lights shall be used upon all fixed signals from one hour before sunset until one hour after sunrise, and whenever the signal indications cannot be clearly seen without them.

824. Signalmen must have the proper appliances for hand signaling* ready for immediate use. These must be used when the proper indications cannot be given by a fixed signal.

*(Hand signaling includes the use of lamp, flag, torpedo and fusee signals.)

825. Hand signals must not be used when the fixed signals are in proper working order. Where hand signals are authorized they must be given from such a point and in such a way that there can be no misunderstanding on the part of enginemen or trainmen as to the signals displayed, or as to the train or engine for which they are given.

826. If any train or engine passes a stop signal the fact, with the number of train or engine, shall be reported to ———.

827. If a signalman has information that an approaching train has parted he must, if possible, stop trains or engines on conflicting routes, clear the route for the parted train, and give the "Train Parted" signal to the engineman.

828. Signalmen must observe all passing trains and note whether they are complete and in order and the markers properly displayed.

829. Only those whose duties require it shall be allowed in the cabin.

Enginemen and Trainmen.

850. Trains or engines shall be run to but not beyond a signal indicating stop.

851. If after accepting a clear signal it is changed to a stop signal before it is reached, the stop shall be made at once. Such occurrence shall be reported to ———.

852. Enginemen and trainmen must not accept clear hand signals as against fixed signals until they are fully informed of the situation and know that they are protected. Where fixed signals are in operation clear hand signals must not be given or accepted against them.

853. The engineman of a train which has parted on approaching an interlocking cabin, must sound the whistle signal for "Train Parted."

854. An engineman receiving a "Train Parted" signal from a signalman must answer by the whistle signal for "Train Parted." When the train has been re-coupled the signalman shall be notified.

855. Sand must not be used over movable parts of an interlocking plant.

856. Enginemen must report to ——— any unusual detention at interlocking plants.

Trains or engines stopped in making a movement through an interlocking plant must not move in either direction until they have received the proper signal from the signalman.

Repairmen.

875. Repairmen are responsible for the inspection, adjustment and proper maintenance of all the interlocking plants assigned to their care.

876. Where the condition of switches or track does not admit of the proper operation or maintenance of the interlocking plant, the fact shall be reported to ———.

877. When any part of an interlocking plant is to be repaired a thorough understanding must be had with the signalman, in order to secure the safe movement of trains and engines during repairs. The signalman must be notified when the repairs are completed.

878. If necessary to disconnect any switch it must be securely fastened before any train or engine is permitted to pass over it.

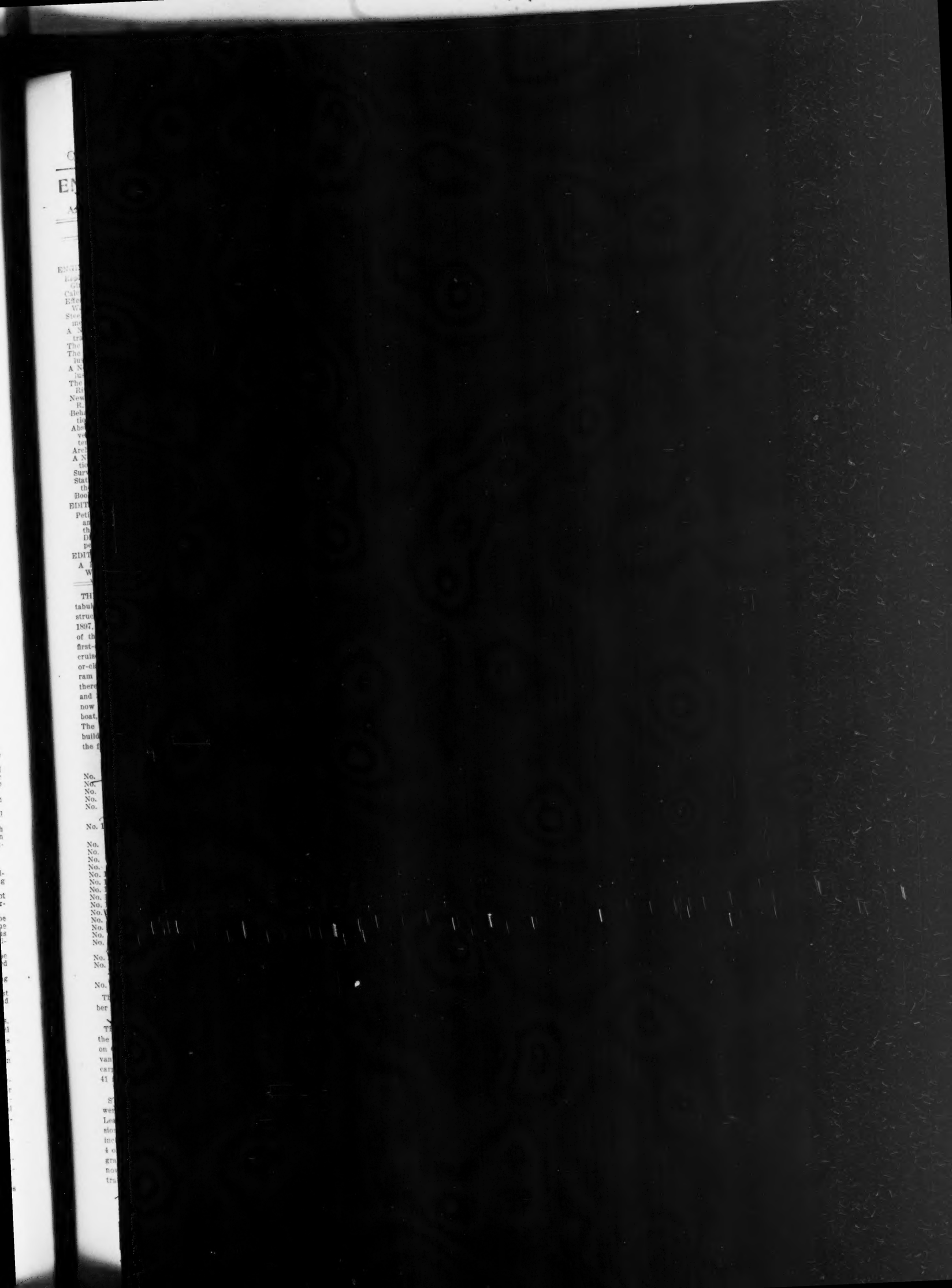
879. No alterations or additions to any interlocking plant shall be made unless authorized by ———.

880. Repairmen when on duty, or subject to call, must keep ——— advised as to where they can be found, and respond promptly when called.

The Committee on Standard Track and Wheel Gages, which was instructed at the Richmond meeting in April last to investigate the practice of the various railways with respect to the widening of gage on curves, presented a long and valuable report, which is reprinted on another page of this issue.

The "nominating committee" reported, and the following were elected to form the nominating committee for the ensuing year: J. M. Hood, President and General Manager Western Maryland R. R.; H. W. Ashley, General Manager Ann Arbor R. R.; W. F. Potter, General Superintendent Long Island R. R.

For Committee on Car Service: Wabash R. R., Louisville & Nashville Ry., New England R. R.

For Committee on Safety Appliances: Cleveland, Cincinnati, Chicago & St. Louis Ry., Chicago & North Western Ry., Philadelphia & Reading Ry.

It was decided that the date for changing fall time tables should be Nov. 14.